ENGINEERING

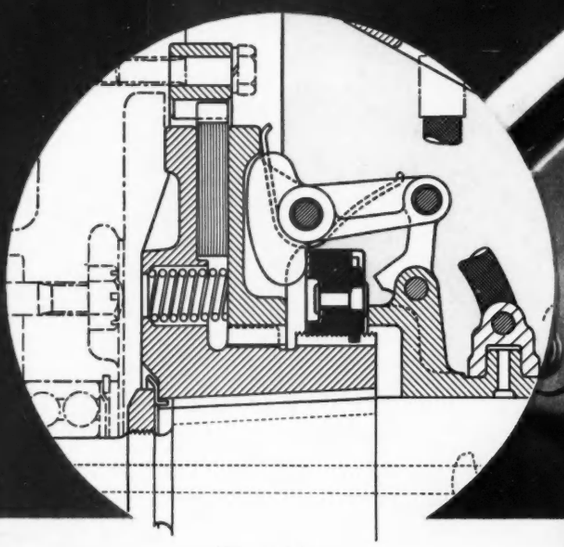
An Illustrated Weekly Journal

35 & 36 BEDFORD STREET, STRAND, LONDON, W.C.2 TELEPHONE: TEMPLE BAR 3463

VOL. 177 No. 4580 LONDON, FRIDAY, JANUARY 8, 1954 PRICE 2s.

UNIVERSITY OF MICHIGAN
JAN 29 1954
ENGINEERING LIBRARY

DROP FORGING JET-TURBINE DISC



Simple adjustment

The Rockford clutch, with its centrifugally-balanced and effective toggle-action, gives a smooth engagement without imposing any running thrust either when engaged or disengaged.

An exclusive device gives, without special tools, an infinitely close adjustment. Fine adjustments can be made, and automatically maintained, without releasing or engaging separate locking devices, which formerly limited adjustments to spacing controlled by notches or holes. The adjustment ring is conveniently accessible, and is painted red for easy identification.

British made, in a range of sizes, by

BORG & BECK COMPANY LTD.
LEAMINGTON SPA, ENGLAND

ROCKFORD

POWER TAKE-OFFS & CLUTCHES

Natural colour photograph by P. G. Hennell, reproduced by courtesy of John Summers & Sons Ltd.

The Davy-United 80" wide 4-High Reversing Cold Mill, installed in the Shotton Works, near Chester, of John Summers & Sons Limited. Powered by a 2,500 h.p. motor, this mill produces cold rolled steel strip up to 74" wide in coils weighing up to 10 tons each.

PROGRESSIVE ENGINEERING AT THE SERVICE OF THE METALS INDUSTRIES

DAVY-UNITED

SHEFFIELD · MIDDLESBROUGH · GLASGOW

Ingot Bogging Mill

FIRTH BROWN

ALLOY STEELMAKERS · FORGEMASTERS · HEAVY ENGINEERS

THOS. FIRTH & JOHN BROWN LIMITED · SHEFFIELD

ENGINEERING

An Illustrated Weekly Journal

Vol. 177 No. 4589 JANUARY 8, 1954

CONTENTS

Leading Article

Managers of the Future 33

Principal Articles

Defenceless Sea Defences 38
Retrospect and Prospect: II—Raw Materials 42
Sintering of Iron Ore 45
Small Hydro-Electric Plants 47
42-ft. Vertical Boring and Turning Mill 48
Diesel-Electric Locomotives for Western Australia 50
Segas Process for making Gas from Oil 52
Hydraulic Presses of 9, 20 and 50 tons 53
Soil Stabilisation 54
Magnetic Brake for Electric Motors 55
Electric Submersible Pump 55
Illumination of Railway Sidings 56
High and Low Pass Filters with Ferroxcube Cores 56
Structural Tests on Tubular Welded Masts 57
Brewery Refrigeration Plant 58
Laying Services Underground 60
Fans and Ducting of Corrosion-Resistant Plastic 60
Stopping and Starting a Stop-watch 61
Canberra Aircraft Equipped as Air Tanker 61
Automatic Oil Burner 61

Weekly Survey 34
Letters to the Editor 34
Personal 37
Business Changes 37
Obituary 37
Book Reviews 41
British Standards 41
Trade Publications 41
Books Received 41
Launches and Trial Trips 52
Labour Notes 63
Notices of Meetings 64

News

Honours List 36
Regional Information Services 39
The North British Locomotive Co. 39
Minister's Message to Atomic Energy Staff 39
Steel Production in Europe 40
Failure of a Highway Bridge 40
Shipbuilding Prospects 40
Electric Power Conference 62
Revision of Bulk Supply Electricity Tariffs 62
Engineering Industry and the Budget 62

★ ★ ★

Published every Friday by Engineering Limited 35 & 36 *Bedford Street, Strand, London, W.C.*2 TELEGRAPHIC ADDRESS *Engineering, Lesquare, London* TELEPHONE *Temple Bar* 3663

★ ★ ★

Subscription Rates for 12 *months, Inland and Abroad* £5 10*s.*, *Canada* £5 5*s. Subscriptions for periods of less than* 12 *months are based on the price of a single copy including postage* [2*s.* 3*d.*]

MANAGERS OF THE FUTURE

THERE was once a managing director who was so enlightened and had such faith in the abilities of his subordinates that he gradually delegated progressively more responsibility to them. His aim was not to reduce the pressure on his own energy and time, but to encourage initiative among his staff, instead of restricting it to himself, and to allow himself time to examine the less obvious but basic factors on which, he felt sure, the success of his works depended. His hold on the reins was not relaxed : it became less rigid and more encouraging.

That is not a fairy story, but it is a rare story. How easy it is to subscribe to such a policy but how difficult to implement it, deliberately and courageously. It has been said many times in this country that too few engineers fill the top posts in management. If that is true it would be reasonable to suppose that the minority of engineers who had privately undertaken courses of management study would find the doors of opportunity wide open to them. But according to the education committee of the Federation of British Industries, men who have qualified in this way are not looked upon by industry as being more acceptable for recruitment and subsequent management training than the graduate in arts or science.

The general attitude of industrial leaders is well stated in the F.B.I.'s booklet published this week (*Education and Training for Management*, price 2*s.*). Dr. P. Dunsheath, chairman of the education committee, states that in view of the self-evident importance of the full development of the manager it is unfortunate that the publicity which education has received in recent years should have created two extreme impressions – the one that education and training for management is just a fashion which, like other fashions, will quietly disappear ; the other that it is the latest panacea for all industrial ills. Its real value, he remarks, has tended to be obscured.

The leaders of industry generally have not been convinced that the education and training facilities provide an answer to a definite need. Support for the courses has come from individual employees rather than from employers. The reasons are not fully known, but the F.B.I. committee attempt an analysis. The criterion of an individual's progress in an industrial organisation is not how much he knows or what qualifications he holds, but how he thinks and acts in any given situation. A firm's assessment of a man's potentiality is based on this, and academic qualifications are only regarded as a means to this end. They will not influence his selection for training, the test for which may be phrased in the question " Is the training going to help him to do his present or future job more efficiently ? " However admirable the formal scheme of training may be, the conviction must grow in the course of time that men are doing their jobs more effectively as a result of the training.

The environment of a works, the committee point out, provides for some people the most effective setting in which they can develop and thrive as individuals. This process, it is argued, derives from the way in which an individual meets the challenge of a difficult situation, from the personal efforts that are made to acquire knowledge and skill, and from the manner in which opportunities are grasped of influencing the thought and action of other people. Those responsible for selecting men for promotion in industry are aware of this, and there are therefore certain reservations in their minds about the benefits of formal instructional classes. There is also the difficulty of deciding whether the long-term advantages of sending a man on a course will outweigh the inconvenience of losing his services.

When it is suggested that formal instruction can at least be used for imparting the techniques of management, industrialists are inclined to take the view that knowledge of the techniques can be gained well enough by having to apply them. " It would be a great mistake," the report suggests, " to assume that this attitude is totally wrong or unjustified, but it is an open question whether, if a really effective means of instruction in the practical use of the techniques of management could be found, this attitude would be overcome." Residential courses of the kind provided at the Administrative Staff College are thought to be out of reach of most of the smaller employers, due either to time or cost. The F.B.I. committee therefore advocate the adoption of less ambitious programmes run on the same lines. The universities must join with the technical colleges and similar organisations – not necessarily to introduce courses for undergraduates or to make the study of management a subject for a degree, but to enlist the aid of the best academic brains and teaching skill. But above all, industry must take the lead. The larger firms have been compelled by circumstances to take action on their own behalf, but there is a great opportunity for the medium and smaller firms, who, after all, are peculiarly susceptible to any faltering in the continuity of management. Management studies must not be confused with management itself, but the firm that ignores them stands to lose in the long run.

Weekly Survey

TOWN GAS FROM PETROLEUM

The traditional fuel for the manufacture of gas in this country is coal but, of late years, the cost of this material has risen, and may perhaps rise still further. The best qualities for gas-making are steadily becoming scarcer. Particularly since the end of the late war there has been a distinctly increasing trend towards petroleum, now produced in huge quantities in many parts of the world, and oil refineries have been erected in various parts of Britain to deal with the crude oil imported from overseas in fleets of large oil tankers. One of the products arising from the manufacture of motor spirit and Diesel oil is a heavy fuel oil which, at present, can be utilised only for limited purposes.

Starting with this product as their raw material, research chemists of the central laboratories of the former South Metropolitan Gas Company have striven to produce a gas which will supplement that obtained from coal; at all events, during the hours of peak demand. As a result of their experiments, which began in 1947, it has been found that when a mixture of superheated steam and vaporised fuel oil react in the presence of a catalyst, a gas very similar in composition to ordinary town gas is produced. The name Segas has been given to the new method and a full-scale commercial plant has been built by the South Eastern Gas Board in co-operation with the Power-Gas Corporation, Limited, Stockton-on-Tees. It is now in operation at the Board's gasworks and is capable of producing up to 800,000 cub. ft. of gas a day—a small but significant part of the Board's production of gas. The plant is described on page 52.

★ ★ ★

FAILURE OF A BRIDGE

A report published by the Ministry of Transport this week will set bridge engineers and users thinking again about the strength of small highway bridges. The report (summarised on page 40 of this issue) deals with the collapse of a highway bridge under a heavy load. The load was, in fact, almost exactly the same as that at which the bridge would have failed according to a straightforward calculation.

During the past few years a number of investigations have been undertaken in an attempt to gain a closer knowledge of the load capacity of small highway bridges. The investigations, made chiefly at the instigation of the Ministry of Transport, have been directed particularly at the hundreds of small bridges in the United Kingdom many of which were built during the period of railway expansion during the last century. These investigations suggested that the restrictions hitherto placed on the maximum vehicle loads permitted to cross any given bridge were unduly conservative.

This has arisen because, in general, the limiting loads have been calculated by the use of over-simplified methods which fail to take into account secondary factors. These factors, taken together, contribute materially to the strength of the bridge. Furthermore, because there have been no major disasters—and, indeed, few failures of any kind—a certain measure of complacency seems to have developed which accepts that there is, necessarily, a fair margin of safety over and above the limiting load determined by simple calculation.

The engineers concerned had made it perfectly clear that they would not accept responsibility for the load passing over the bridge. That the load was taken over the bridge was principally due to the fact that, if the load was to be taken by road, then some risk had to be taken by the haulier handling it. The accident, which fortunately involved no loss of life, will correct any assumption that these old bridges have invariably a margin of load capacity.

★ ★ ★

DAMAGE BY FLOOD

Civil engineers of the various river boards and local authorities have rendered a great national service in restoring and improving the sea defences of the East Coast in the short time at their disposal. The defences have this week been tested by the abnormally high water levels, and although some damage resulted no widespread flooding occurred. As Mr. Duvivier remarked in his paper to the East Coast Flooding Conference (reported on page 38 of this issue), for the first time the problem has been dealt with on a national basis.

Points emphasised during the discussion were the need for a sense of proportion, and a comprehensive gauging system linked with extensive research. It would be absurd to try and protect from rare and phenomenal sea-levels a few oyster-beds or acres of marsh-land mostly inhabited by sea-gulls, and it seems irrational to locate and build capital plants costing many millions of pounds in places where all that was expected to save them from flooding was an earthen embankment.

An understanding of the impact of waves and the dissipation of their energy is important, but, unfortunately, there appears to be no record of wave shapes as they occurred during the night of January 31-February 1, 1953. One speaker from Holland proposed the erection of an international observation post, possibly on the Dogger Bank, which would enable wave-shapes in the open sea to be recorded, and, by reference to the levels being attained by a surge at coastal observation points, assist greatly in determining the direction of a surge and its probable point of maximum coastal effect.

It would seem necessary to determine whether seepage or over-topping is likely to be the cause of failure of any particular length of sea defence. As to seepage, not only is it necessary to know whether there is a previous stratum below, but also to know the appropriate rear slope to give to an embankment, so as to ensure that the seepage path through the material of which a bank is composed is sufficiently long, within the bank, to reduce the seepage velocity to a harmless amount. The most suitable design for the seaward side of a defence will surely differ for different reaches, depending on the prevailing tidal range, the height of surge and the slope of the littoral, the latter determining the necessity for effective groynes. These are a few of the questions to be considered if maximum efficiency is to be attained for the money spent. Where an expenditure of several million pounds is envisaged, a few thousands, or even a few hundred thousands, would be a sound investment.

★ ★ ★

COAL-BURNING GAS-TURBINE LOCOMOTIVE

The North British Locomotive Company and C. A. Parsons and Company are working on the design of a coal-burning gas-turbine locomotive, as reported on page 39. The problem of fly-ash erosion of the turbine blades is being overcome by employing a cycle in which the pulverised coal is introduced into the air stream after it has left the turbines. Success with the prototype will be of great significance to railways generally, and to British Railways particularly. It will, too, be a great achievement on the part of the two firms who are pioneering the work.

Letters to the Editor

STEEL AND ALUMINIUM ALLOYS IN PROXIMITY

Potential Danger of Electro-Chemical Relations

SIR, The problems which arise when high-tensile steel is used in conjunction with aluminium have recently been discussed in relation to the design of bridges[1] and of aircraft.[2] On both occasions, the audience must have gained the impression that the difficulties spring solely from discrepancies between the elastic properties or thermal expansion of the two materials. The possibility of trouble caused by corrosion-couples was not discussed; one speaker indeed expected benefits from the high corrosion resistance of aluminium alloys.

A word of warning may be timely. That aluminium alloys do, under many conditions, exhibit excellent corrosion resistance is not in doubt. Yet the free-energy decrease which attends the entry of metal into combination is higher for aluminium than for iron. The electromotive force of the corrosion cell aluminium/oxygen is about double that of iron/oxygen. The cause of the high corrosion resistance sometimes shown by aluminium and certain aluminium alloys (if suitably heat-treated) is a protective and normally self-healing oxide film, having a thickness of the order of 10^{-7} in. If that tenuous film breaks down and fails to repair itself, serious corrosion can set in. To avoid the risk of this happening, the choice of alloy and its heat-treatment and surface condition must be considered along with the nature of corrosive substances present in air, water or soil — as the case may be. To prefer alloy A, which gives a few extra tons per square inch greater mechanical strength as compared with B but a much smaller chemical strength, is generally wrong; yet I am assured that the preference for A without regard to the required chemical resistance is only too common to-day.

If the aluminium alloy is in contact with steel, complications increase. If both metals were film-free, a cell such as aluminium/salt solution/iron might produce an appreciable electric current, maintained by the corrosion of the aluminium. If the light alloy carries its film, the current is much smaller, and even its direction may vary. Thus an alloy containing magnesium may be anodic to steel under conditions where one containing copper would be cathodic.

Even heat-treatment can reverse the polarity. Twenty-two years ago, von Zeerleder[3] recorded that Dural aged at room temperature was cathodic towards steel, whereas if aged at 140 deg. or 160 deg. C. it was anodic. This result was obtained by direct electro-chemical measurements, and the practical consequences were shown in salt-spray tests lasting a month. When ageing had been carried out in the cold, iron rivets in Dural plates were rusted, the Dural being protected. After ageing at 140-160 deg. C. (a temperature lower than would usually be employed for temper-hardening) the Dural was corroded while the iron rivets were protected.

Sometimes the surface condition is important in deciding whether the corrosion current remains small or becomes appreciable, but much depends on the environment. In a rural atmosphere there is usually little danger; in an industrial atmosphere more attack occurs, but the worst problems concern marine conditions. Chlorides (which are sometimes present even in inland air) may set up corrosion unless preventive measures are adopted. If once, for any reason, corrosion has definitely started

either on steel or a light alloy, it may be difficult to arrest it.

The possibility of micro-couples as well as macro-couples must be borne in mind. In his extensive study of plumbing systems combining copper pipes with galvanised tanks, Kenworthy[4] found that the macro-cell formed by the pipes as cathodes and tank as anode is far less dangerous than the micro-cells formed where water, having acquired traces of copper salts by an attack so trivial as to be harmless to the pipes, has deposited metallic copper on the tank. On one housing estate, every installation failed within four years, as a result of 32 parts of copper in 10^8 parts of water. Aluminium is at least equally sensitive to traces of copper in water; 2 parts of copper in 10^8 parts of water were found by Porter and Hadden[5] to stimulate the corrosion of aluminium if calcium bicarbonate and chlorides were also present. When steel and light alloy are in proximity, the micro-cells demanding consideration include aluminium/magnetite, which may be expected to give a higher electromotive force than aluminium/iron.

The presence of stresses, tensional or alternating, can enhance the danger. Corrosion fatigue can cause failure at a stress range where purely physical fatigue produces negligible damage over long periods. Yet in the Fatigue Conference of the Royal Aeronautical Society,[2] corrosion fatigue received scant mention, although one speaker did recommend nitriding, shot-peening, galvanising and nickel-plating in combating corrosion fatigue (apparently in steel); many authorities would question the use of nickel for this purpose except where the nickel-plating can be obtained entirely pore-free. Another speaker described corrosion fatigue as "a very messy subject," and after warning his hearers "not to forget it" added "I feel entitled not to soil my talk with it." This unwillingness to consider factors which are aesthetically or intellectually unattractive is to-day very common; it is not the least of the obstacles confronting those who seek to solve the practical problems of corrosion.

Unless there exists somewhere a *cache* of undisclosed information, our knowledge is seriously incomplete. Owing to the number of factors capable of independent variation, it would long remain incomplete even if a comprehensive programme of tests were started to-morrow. The object of this letter is not to provide a universal remedy, but to suggest that the problems of using steel and light alloys in conjunction will be affected not only by their mechanical and thermal differences but also by their electrochemical relations.

If the position is frankly recognised, there are no grounds for pessimism. Indeed progress is being made, and a notable contribution has recently come from within the aluminium industry.

In a recent article on "Aluminium and Bi-metallic Joints," J. M. Whiteford[6] discusses the design of ships having steel decks and hulls with superstructures, bulkheads, casing and/or boat decks of aluminium alloy. He starts by stressing "the importance of appreciating and guarding against the risk of corrosion resulting from the connection of aluminium to other materials." Having clearly stated the danger, he then describes ingenious methods – based on design – for avoiding trouble. Even those who, like myself, are unqualified to assess the structural proposals and would reserve judgment on certain points of electro-chemistry, can at least applaud the soundness of the approach. Provided that, in analogous applications, the existence of the hazard is admitted, it should usually be possible to avoid it, by suitable design and protective measures. The real danger is a lack of frankness about the behaviour of certain materials under certain conditions.

Yours faithfully,

U. R. EVANS.

Department of Metallurgy,
University of Cambridge.
December 26, 1953.

REFERENCES

[1] Welding Structures Conference, Nov. 23-26, 1953, organised by the Ministry of Works, Institution of Civil Engineers and Institution of Structural Engineers.
[2] Fatigue Conference, *Jl. Royal Aeronautical Society*, vol. 57, page 559 (1953).
[3] A von Zeerleder, *Jl. Inst. Met.*, vol. 46, page 180 (1931) (see Figs. A and B).
[4] L. Kenworthy, *Jl. Inst. Met.*, vol. 69, page 67 (1943).
[5] F. C. Porter and S. E. Hadden, *Jl. App. Chem.*, vol. 3, page 385 (1953).
[6] J. M. Whiteford, *Shipping World*, Sept. 2, 1953.

"ENGINEERING"

The New Layout

SIR, The writer would like to congratulate you on the new layout of ENGINEERING, which is in general a great improvement. Many years ago, but not from this company, I wrote and suggested alterations but at that time you were very much against making any change. The new type is very much nicer to read.

One of the difficulties of reading ENGINEERING in the past has been that of identifying the illustrations with the text. One has a large number of technical articles to look through and one cannot afford the time to study all of them in great detail. It is therefore a great convenience if, when looking through an article which is likely to be of importance or interest, one can easily find in the text where a particular illustration is referred to.

Yours faithfully,

R. T. MEDD,
Managing Director.

Small Electric Motors, Limited,
Beckenham.

SIR, I was pleasantly surprised when I opened the issue of January 1 of your journal to see such a marked improvement in the layout. As an information officer it is my responsibility to glance through many journals to ascertain their contents, and in the past I have found it very difficult to spot the contents list in ENGINEERING. With your new layout, however, it is most useful to have such a readable contents list at the beginning of each issue. I also think that the new type face is a great improvement.

The editorial staff are to be congratulated on the new arrangements. With best wishes for continued success for ENGINEERING,

Yours sincerely,

P. E. COLINESE,
Assistant Information Officer.

The British Iron and Steel Research Association.

THERMODYNAMICS APPLIED TO HEAT ENGINES

SIR, I would like to reply to your review of my text-book "Thermodynamics Applied to Heat Engines" (fifth edition), which appeared on page 771 in ENGINEERING, December 18, 1953. The review consists mainly of a criticism of a new article entitled "A Conception of Entropy from Availability of Heat," which appears on page 755 of the book. Your reviewer quotes four instances in order to prove that the conception does not hold.

All four of these objections occurred to me, together with several others, when I first began to work on the problem, but I satisfied myself that they did not interfere with its soundness. Your reviewer's objections appear to be due to a misunderstanding of my definition; he has overlooked the fact that the cooling process through the Carnot engines is a gradual process.

I will deal with each of the four objections in the order in which they appear in the review.

(1) *That the stepped areas representing the work done by the Carnot engines would, in the limit, vanish* :—These areas would never vanish, however small the temperature degree is assumed to be. The cooling process would always be represented by a stepped curve, the size of the steps depending on the scale chosen for the temperature and entropy ordinates.

(2) *That it could be arranged so that the whole of the heat in the substance would be available for work* .—This could not be arranged in a gradual cooling process. It is explicitly stated in the definition that entropy is the maximum work obtainable by a gradual cooling process through a series of Carnot engines, each causing unit drop in temperature.

(3) *That as much work is theoretically obtainable from steam at* 50 *lb. per square inch pressure and* 400 *deg. F. as from steam at* 700 *lb. per square inch and* 940 *deg. F. because the entropy in each case is the same* :—This is so if the steam is gradually cooled through a series of Carnot engines, each causing unit temperature drop.

(4) *That on page* 762 *of my textbook, the reader is told that the efficiency of Carnot engines, working with equal temperatures and ranges, will vary with the temperature-entropy curve of the substance from which they extract their heat* :—No such statement is made or implied. It is the average efficiency of all the engines of the series which affects the change of entropy during a given process.

I would also like to add, in support of this conception, that the equation deduced from it for the value of the entropy of a substance, gives the same result as the orthodox equation :

$$\phi_2 - \phi_1 = K_p \log_e \left(\frac{T_2}{T_1}\right).$$

Yours faithfully,

E. H. LEWITT.

50, Hertford-avenue,
London, S.W.14.
December 23, 1953.

SIR,—Dr. Lewitt's conception of entropy was quoted in full in the review of his book in order that there should be no possibility of misunderstanding it on the part of your readers. Stated briefly, it was that the total entropy of any substance is equal to the total work obtainable by cooling the substance to the absolute zero of temperature by a series of Carnot engines, each causing unit temperature drop.

Quite apart from the physical incongruity of equating entropy with work, the process assumed for cooling involves a theoretical impossibility. By definition, a Carnot engine has to take in the whole of its heat isothermally, which precludes any reduction in the temperature of its source of heat. A finite amount of cooling of its source by such an engine is therefore impossible. I will now deal with Dr. Lewitt's four points.

(1) It is impossible to imagine any cooling process in which the temperature of the substance being cooled drops by definite abrupt steps, without passing through the intermediate values.

(2) With the assumption—stated explicitly in the review—that it was possible for heat to be discarded at the absolute zero of temperature, the phrase quoted is strictly accurate. The only reason for the unavailability of any heat is the fact that in practice it has always to be discarded

above zero temperature. The theoretical impossibility of cooling any substance with Carnot engines working with finite temperature drops has been referred to above.

(3) If Dr. Lewitt accepts as true a statement intended to show to what absurdities his theory of entropy could lead, there is not much to be said. Not only is it contrary to common sense, as well as to all experience, but any student should be able to tell him that the high-pressure steam could turn into useful work at least 306 B.Th.U. per lb. more than the low-pressure steam, assuming both to be used in ideal engines.

(4) If the reviewer has misunderstood the author's meaning, he offers his apologies, but has to say that his interpretation of the text seemed not merely the only one possible, but also to be indirectly confirmed by the author's notions concerning the identity of entropy with available heat. Finally, the orthodox equation for entropy that he gives cannot be deduced from his conception of entropy because the equation depends on the assumption of a series of infinitesimally small temperature drops, as pointed out in the review.

Yours faithfully,

YOUR REVIEWER.

★ ★ ★

HONOURS LIST

Many engineers, industrialists and scientists are among those whose names are contained in the New Year Honours List, published on January 1. Included among them are those mentioned below.

Knights Bachelor

Donald F. Anderson, chairman, Shipping Federation, and President, Chamber of Shipping of the United Kingdom ; Dr. Edward C. Dodds, Courtauld Professor of Bio-Chemistry, London University ; George F. Earle, C.B.E., chairman, Associated Portland Cement Manufacturers, Ltd.; John B. Elliot, formerly chairman, Railway Executive, and now chairman, London Transport Executive ; Ernest H. Lever, chairman and chief executive, Steel Company of Wales, Ltd.; Oliver Lyle, O.B.E., for services in promoting fuel efficiency ; Herbert J. B. Manzoni, C.B.E., city engineer and surveyor, Birmingham ; Edward T. Paris, C.B., chief scientific adviser, Home Office ; Walter C. Puckey, formerly deputy controller of supplies (air), Ministry of Supply ; William G. Radley, C.B.E., engineer-in-chief, General Post Office ; John O. Sanders, C.M.G., general manager, Malayan Railway, and member for Railways and Ports, Federation of Malaya; Kenneth D. L. Sinclair, D.L., chairman, Belfast Harbour Commissioners ; Lawrence J. Wackett, for services to the aircraft industry in Australia.

Order of the Bath

K.C.B. Sir James R. C. Helmore, K.C.M.G., Permanent Secretary, Ministry of Supply ; Victor G. Shepheard, C.B., director of naval construction, Admiralty.

C.B. A. T. Barnard, O.B.E., chief superintendent, Royal Ordnance Factories, Woolwich ; Major-Gen. R. G. Collingwood, C.B.E., D.S.O.; A. J. Filer, under-secretary, Ministry of Works ; Major-Gen. F. M. Hext, O.B.E., R.E.M.E.; Rear-Admiral (E) Iain G. Maclean, O.B.E.; M. P. Murray, under-secretary, Ministry of Fuel and Power ; Rear-Admiral (E) Leopold E. Rebbeck ; H. J. Watson, deputy director, dockyards, Admiralty ; Engineer Rear-Admiral J. W. Wishart.

Royal Victorian Order

K.C.V.O. James McFadyen McNeill, C.B.E., M.C., managing director, John Brown and Co., Ltd., Clydebank.

Order of Saint Michael and Saint George

C.M.G. N. C. Robertson, M.B.E., director-general of electronics production, Ministry of Supply; I. Clunies-Ross, chairman, Scientific and Industrial Research Organisation, Australia.

Order of the British Empire

K.B.E. Leonard P. Lord, chairman and managing director, British Motor Corporation, Ltd.; Commander Seton, S. C. Mitchell, C.B., O.B.E., R.N.(ret.), controller of guided weapons and electronics, Ministry of Supply.

C.B.E. J. A. Burnett, divisional road engineer, Scotland, Ministry of Transport and Civil Aviation ; G. T. Bussey, assistant secretary, Ministry of Fuel and Power ; N. C. Chapling, managing director, Cable and Wireless, Ltd.; W. S. Chevalier, clerk of the Metropolitan Water Board ; H. W. Coales, O.B.E., M.C., deputy chief engineer, Ministry of Housing and Local Government ; W. K. Davey, chairman, London Metal Exchange ; St. J. de H. Elstub, director, Metal Division, Imperial Chemical Industries, Ltd.; H. Eyles, O.B.E., formerly secretary, Birmingham Chamber of Commerce ; W. G. Fergusson, assistant secretary, Ministry of Materials; R. D. Gwyther, M.C.,M.I.C.E., senior partner, Coode and Partners, consulting engineers, London ; W. Harris-Burland, O.B.E., T.D., formerly British chairman, Combined Steel Group, Control Commission for Germany ; E. J. Holford-Strevens, joint controller for North-Western region, Board of Trade and Ministry of Supply ; B. P. Ingamells, director, merchant shipbuilding and repairs, Admiralty ; C. R. King, chairman, East Midlands Electricity Board ; Professor M. A. Lewis, Professor of History and English, Royal Naval College, Greenwich ; G. J. S. Little, G.M., assistant engineer-in-chief, General Post Office ; A. G. B. Owen, joint managing director, Rubery, Owen and Co., Ltd., Birmingham ; G. D. Smith, managing director, Bush Radio, Ltd., and formerly chairman, Radio Industry Council ; B. A. Southgate, director, Water Pollution Research Laboratory, Department of Scientific and Industrial Research ; H. E. Thatcher, formerly assistant secretary, Ministry of Supply ; Captain G. Villar, R.N. (ret.), M.Inst.N.A., general manager Southampton works and director, John I. Thornycroft and Co., Ltd.; F. W. G. White, chief executive officer, Scientific and Industrial Research Organisation, Australia ; M. D. N. Wyatt, chairman, Airwork, Ltd.

O.B.E. W. T. I. Alagaratnam, director of irrigation, Ceylon; Lieut.-Colonel (temp.) A. J. Apperley, R.E.M.E.; T. H. Baines, deputy director of radio equipment (production) Admiralty; J. Begbie, superintendent engineer, Marine Department, Nigeria; Commander (E) H. G. R. Binning, R.N. (ret.); A. D. M. Brown, chief engineer, Iraq State Railways; H. Brown, superintending mechanical and electrical engineer grade II, Air Ministry; Lieut.-Colonel A. J. Burgess, T.D., R.E.M.E.; J. Chamberlain, chief engineer, Aiton & Co., Ltd., Derby; E. J. Cowles, principal, Ministry of Materials; R. K. Cushing, principal scientific officer, Ministry of Supply; A. V. Dalzell, secretary-director, Federated Quarry Owners of Great Britain; N. G. Ferguson, state engineer, Kelantan, Colonial Engineering Service; E. H. Greet, senior engineer, Civil Engineering Department, Office of Crown Agents for the Colonies; J. W. Jehu, formerly deputy director and engineer-in-chief, Posts and Telegraphs Department, Nigeria; W. Langford, manager for France, of Associated British Machine Tool Makers, Ltd.; I. M. Leslie, editor, *The Builder*; J. H. McCuaig, shipyard manager, Harland and Wolff, Ltd.; T. W. McCullough, deputy chief inspector of factories, Ministry of Labour and National Service; A. Marsh, director, National Smoke Abatement Society; F. V. Mills, chief executive officer, Ministry of Transport and Civil Aviation; A. S. Mitson, assistant director, electronics production, Ministry of Supply; R. A. Moir, M.C., chief telephone engineer, Standard Telephones and Cables, Ltd.; P. E. Montagnon, senior principal scientific Officer, Ministry of Fuel and Power; J. Mould, deputy chairman, East Midlands Electricity Board; W. C. Muirhead, special director, English Steel Corporation, Ltd., Sheffield; A. J. Nicholas, director and general manager, South Wales Switchgear, Ltd.; A. J. Perkins, superintendent, Royal Ordnance Factory, Cardiff; T. G. Poppy, controller, Standards Department, Board of Trade; M. J. L. Pulling, senior superintendent engineer (television), British Broadcasting Corporation; W. H. Purdie, engineering director, William Doxford and Sons, Ltd., Sunderland; B. A. Renton, principal, Ministry of Materials; A. P. Ruddy, general manager, High Speed Alloys Mining Co., Ltd., Burma; R. G. Shepherd, principal officer, East of England Marine Survey District, Ministry of Transport and Civil Aviation; H. F. H. Shields, managing and technical director, British Ropeway Engineering Co., Ltd.; Commander (E) D. P. Sparham, R.N.; R. T. Stevens, M.B.E., director, electricity and telephones, Mauritius; J. M. Stewart, technical manager, Ulster Steamship Co., Ltd., Belfast; A. G. Tarrant, senior principal officer, Road Research Laboratory, Department of Scientific and Industrial Research; W. G. Woodhead, general manager, English Coaling Co., Port Said; Lieut.-Colonel A. H. Wynn, R.E.M.E.

M.B.E. W. J. Baker, divisional manager, Northern Division, South Western Gas Board ; J. S. Ball, head of design and development department, Henry Simon, Ltd., Stockport ; W. L. Barker, vice-chairman, Wearside district advisory committee, Northern Regional Board for Industry ; O. H. Barron, engineer, planning and installation department, British Broadcasting Corporation ; Frank Boardman, for services as engineer and manager, Cardiff Undertaking, Welsh Gas Board ; W. H. Bowker, M.M., formerly inspector-in-charge, aeronautical inspection directorate, Ministry of Supply ; C. W. Brown, local fuel overseer to various urban and rural districts in Hertfordshire ; J. L. Buchan, director and manager, William Broady and Son, Ltd., Hull ; H. J. Clark, senior technical officer, Ministry of Works ; H. J. M. Couch, senior ship surveyor, Ministry of Transport and Civil Aviation ; H. J. Cull, assistant head, Department of Physics and Mathematics, Birmingham College of Technology ; L. T. Dawes, commercial manager, secretary and director, Beyer, Peacock and Co., Ltd., Gorton, Manchester ; James Dawson, engineer, Northern General Transport Co., Ltd. ; W. J. Dixon, deputy contracts manager (pricing), Automatic Telephone and Electric Co., Ltd., Liverpool ; A. W. Dunlop, engineering superintendent, Short Brothers and Harland, Ltd., Belfast ; H. F. W. Golding, chief inspector, Northern Aluminium Co., Ltd., Banbury, Oxfordshire ; Albert Goodwin, member, North Staffordshire district advisory committee, Midland Regional Board for Industry ; F. H. Green, senior executive officer, Ministry of Supply ; W. H. F. Griffiths, chief engineer, H. W. Sullivan, Ltd., Peckham, London, S.E.15 ; W. H. R. Gunner, transport officer, Central Mechanical Equipment Department, Southern Rhodesia ; H. J. Harbour, test controller, E. K. Cole, Ltd., Ekco Works, Southend-on-Sea, Essex ; Gordon Harley, M.C., training service officer, Ministry of Labour and National Service ; John Hastings, civilian workshop officer (technical grade I), R.E.M.E. workshops, Aldershot ; D. J. Horan, formerly chief draughtsman, Sudan Railways; Geoffrey Houghton, chief technical instructor, radar section, Technical Training College, Indian Air Force, Jalahalli, India ; G. J. Hughes, laminated department, Bakelite, Ltd., Birmingham ; W. R. Ingram, formerly superintendent of works, Ministry of Works ; E. J. Jarvis, deputy manager, Surrey sub-area, South Eastern Electricity Board ; W. C. Johnson, chief chemist, Baird and Tatlock (London), Ltd., Chadwell Heath, Essex ; P. S. Kemsley, works superintendent, gas-turbine combustion production factories, Joseph Lucas, Ltd., Burnley ; Major Adam Kilburn, R.E.M.E.; W. R. J. Leach, higher executive officer, Ministry of Supply ; Horace Le Fevre, higher executive officer, Ministry of Transport and Civil Aviation ; Colin McKay, head foreman shipwright, John Brown and Co., Ltd., Clydebank ; W. R. Maunder, technical officer, grade I, Ministry of Transport and Civil Aviation ; J. B. Mills, chief designer, Fodens, Ltd., Sandbach, Cheshire ; J. M. Montague, senior executive officer, Ministry of Materials ; E. A. Musto, senior executive officer, Ministry of Fuel and Power ; R. P. Pedley, research engineer, Percival Aircraft, Ltd.; E. J. Redmond, executive officer, Ministry of Transport and Civil Aviation ; G. H. Rippon, technical director, Maun Industries, Ltd., Mansfield ; John Rix, production engineer, Vosper, Ltd., Portsmouth ; H. W. Sealley, dock superintendent, Avonmouth Docks ; J. T. Sharp, formerly senior assistant engineer, generation construction department, South West Scotland Division, British Electricity Authority; J. D. D. Shaw, managing director, James Kilpatrick and Son, Ltd., electrical engineers, Paisley, Scotland ; A. H. Shipley, manager, engineering department, Dendex Brushes, Ltd., Chepstow, Monmouthshire ; L. A. L. Siffre, district superintendent, Southampton Mercantile Marine Office, Ministry of Transport and Civil Aviation ; S. J. W. Snook, higher executive officer, Board of Trade ; P. F. T. Snow, senior assistant, Ministry of Materials ; C. W. Stanbridge, assistant manager, Royal Ordnance Factory, Chorley; J. A. Stringer, formerly production officer, Board of Trade ; J. I. Swan, secretary, Greenock Harbour Trust, Greenock ; Captain L. H. J. Thompson, master, M.S. " Whitewing," General Steam Navigation Co., Ltd., London ; D. R. Todd, M.Inst.N.A., naval architect, John I. Thornycroft and Co., Ltd., Southampton ; A. F. Tosh, director and works manager, Summerson's Foundries, Ltd., Darlington ; C. H. Wainwright, higher executive officer, Ministry of Transport and Civil Aviation ; Miss Mildred B. Waters, higher executive officer, Department of Scientific and Industrial Research ; Lieutenant (E) E. C. Webb, R.N. (ret.) ; Lieutenant (E) D. F. Westbrook, R.N. (ret.) ; Major Thomas Wheelwright, R.E.M.E. ; A. J. C. White, higher executive officer, Board of Trade ; Captain F. L. Whittle, R.E.M.E. ; G. H. G. Wills, secretary, Southampton district, Shipping Federation ; John Wilson, general works manager, Blaw Knox, Ltd., Brompton-road, London ; S. A. Woodcock, M.M., Hampton Works, Metropolitan Water Board.

PERSONAL

SIR WILLIAM FARREN, C.B., M.B.E., F.R.S., technical director of A. V. Roe & Co., Ltd., Manchester, has been elected a foreign honorary Fellow of the International Institute of Aeronautical Sciences Inc., U.S.A.

SIR ERIC DE NORMANN, K.B.E., C.B., deputy secretary, Ministry of Works, is shortly to retire. MR. E. F. MUIR, C.B., now deputy secretary, Ministry of Materials, is to be his successor.

MR. H. J. MANZONI, C.B.E., M.I.C.E., city engineer and surveyor, Birmingham (who has just been created a Knight Bachelor), has been made a member of the Board of Governors of Loughborough College of Technology.

MR. H. DAVIES, M.I.Loco.E., general manager of W. G. Bagnall Ltd., Stafford, since 1947, has been elected a director.

MR. A. D. YOUNG, M.A. (Cantab.), Professor at the College of Aeronautics, has been appointed to the University of London Chair of Aeronautical Engineering, tenable at Queen Mary College.

MR. A. H. HUMAN, C.B.E., sole partner of McLellan and Partners, 32, Victoria-street, London, S.W.1, retired on December 31, 1953. From January 1, the practice is being carried on in the same manner by SIR HENRY CLAY, BT., MR. G. N. HEWETT and MR. T. B. ROLLS, hitherto technical directors, who, together with the partners of Merz and McLellan, will be the new partners.

MR. E. G. HORTON, B.Sc., M.I.C.E., district engineer, London district, London Midland Region, British Railways, retired on December 31 after 42 years of service.

MR. J. W. BAILLIE has relinquished his position of managing director, Horseley Bridge and Thomas Piggott Ltd., but will remain on the board. Mr. J. S. CHRISTIE and MR. VINCENT SENIOR have been appointed joint managing directors.

The British Oxygen Co. Ltd., Bridgewater House, Cleveland-row, London, S.W.1, announce the appointment of DR. P. H. SYKES, M.Sc., F.R.I.C., general manager, research and development, to the board of directors, and DR. N. BOOTH, B.Sc., F.R.I.C., to general manager, following Dr. Sykes.

MR. L. W. H. REA, B.Sc. (Eng.), recently appointed general manager, Edwin Danks & Co. (Oldbury) Ltd., has been elected a director, following the resignation of CAPTAIN (E) GREGSON, R.N.R. MR. W. SMITH, works manager, has also been elected a director, in place of MR. J. W. HARGREAVES, who has also resigned.

MR. FRANK TAYLOR, chairman of Taylor Woodrow Ltd., has been elected chairman of the Export Group for the Constructional Industries for the present year.

MR. L. EVANS has been made engineer-in-charge of the low-power television transmitting station of the British Broadcasting Corporation, near Douglas, Isle of Man.

MR. ARTHUR BROOMHEAD, a local director of Thos. Firth & John Brown Ltd., since 1952, has been appointed a director of the company.

MR. W. H. TAIT, technical director of the Glacier Metal Co. Ltd., retired from the board on December 31, 1953, but will continue to serve the company in the technical field.

MR. CHARLES BUSH, F.C.I.S., and MR. GEORGE REDFERN, M.A. (Cantab.), A.M.I.E.E., have been appointed directors of Newman Industries Ltd., Yate, Bristol.

MR. F. E. WILSON has been elected a director of E. H. Jones (Machine Tools) Ltd., Garantools House, Portslade, Sussex.

MR. ALEC MILLIGAN, 9, Queen's Gate Terrace, London, S.W.7, has been appointed London manager of Norman Gledhill & Co. Ltd., Vicarage-lane, Blackpool.

BUSINESS CHANGES

THE BRITISH THOMSON-HOUSTON CO., LTD., Rugby, state that the new premises of their Middlesbrough office are at Prudential Chambers, 27, Albert-road.

TURNER & NEWALL LTD. have acquired a controlling interest in the firm of GLASS FABRICS LTD., small-scale manufacturers of glass textile products in Dungannon, County Tyrone, Northern Ireland.

MINIATURE BEARINGS LTD. have removed to 4 and 5, William IV-street, Strand, London, W.C.2. (Telephone : COVent Garden 3366-7.)

THE CONE AUTOMATIC MACHINE CO. (GREAT BRITAIN) LTD., Solihull Chambers, 14, High-street, Solihull, Birmingham, has been formed as a subsidiary company of the CONE AUTOMATIC MACHINE CO. INC., Windsor, Vermont, U.S.A. Inquiries should continue to be addressed to the agents, CHARLES CHURCHILL & CO., LTD., Coventry-road, South Yardley, Birmingham.

THE ASSOCIATION OF HAND LIFTING TACKLE MAKERS has extended its scope to include electrically-operated hoists and pulley blocks. Its name has been changed to ASSOCIATION OF LIFTING TACKLE MAKERS, Chamber of Commerce, 95, New-street, Birmingham, 2.

The Rootes Group have registered a company, in Melbourne, under the name of ROOTES (AUSTRALIA) LTD. This will acquire the existing business carried on by ROOTES LTD. at Fisherman's Bend, where Humber, Hillman and Sunbeam-Talbot motor cars, and Commer and Karrier commercial vehicles are assembled.

SHEEPBRIDGE ENGINEERING LTD. announce that, by agreement with the UNITED STATES PIPE AND FOUNDRY CO., special products division, Burlington, New Jersey, U.S.A., the special method developed by the American firm for making long cast cylinders and tubes, can be employed by two subsidiary companies of Sheepbridge Engineering Ltd., namely, SHEEPBRIDGE STEEL CASTINGS LTD., Sutton-in-Ashfield, Nottinghamshire, and SHEEPBRIDGE STOKES LTD., Chesterfield.

★ ★ ★

Obituary

SIR FREDERICK MILLS, Bt.
Steelmaker and Parliamentarian

Steel metallurgists in many parts of the world will learn with regret of the death of Sir Frederick Mills, Bt., J.P., D.P., of Rushlake Green, Heathfield, Sussex, which occurred on December 31. Sir Frederick was a former chairman and managing director of the Ebbw Vale Steel, Coal and Iron Company, Limited (the iron and steel assets of which were acquired in 1935 by Richard Thomas and Company, Limited, later Richard Thomas and Baldwins, Limited). Frederick Mills was born at West Hartlepool on April 23, 1865, and after being educated privately in Newcastle-upon-Tyne, studied engineering at the Durham University College of Science. From 1881 until 1886 he served his engineering apprenticeship at Palmer's Shipbuilding and Iron Company, Limited, Jarrow-on-Tyne. He remained at Jarrow until 1888, thereby gaining his first insight into steel manufacture under the late Mr. Herbert Le Neve Foster. As a result of this experience he was appointed the first steelworks manager of the Stockton Malleable Works, at the early age of 23. These works subsequently became a constituent part of the South Durham Steel Company, Limited. Eight years later, in 1896, Mills became manager of the Wishaw Steelworks of the Glasgow Iron Company, Limited. He remained at Wishaw for three years during which he acquired a well-deserved reputation as a steel technician and works manager.

In 1899 Mills was appointed general manager of the Ebbw Vale Works, and in subsequent years carried out a number of modernisation schemes and plant enlargements. In 1911 he was elected managing director of the company and became chairman and managing director in November, 1919, on the retirement of Sir Charles Allen. In addition to his responsibilities at the works he took part in public affairs of the County of Monmouth, becoming Justice of the Peace in 1900 and High Sheriff in 1912. In 1917 he was made a Deputy Lieutenant for Monmouthshire for his work as a member of the Territorial Force Association. He then held the rank of Lieut.-Colonel and was responsible for raising a battalion of the South Wales Borderers. During the lean years which followed the war of 1914-18 he displayed great energy and leadership in maintaining and creating new outlets for his firm's products, thus keeping the works in operation and avoiding unemployment. In recognition of his establishment of the Ebbw Vale Industrial Council and also for his services during and after the war, he was created a Baronet in 1921. Sir Frederick retired from his industrial appointments in 1929, but although he was then 64 years of age, decided to enter Parliament. In 1931 he was elected Unionist Member for East Leyton and continued to represent that constituency until 1945 when, at the age of 80, he retired from public life.

Sir Frederick became a member of the Institution of Civil Engineers in 1901 and of the Institution of Mechanical Engineers in 1905. He was made a member of the Iron and Steel Institute in 1896, was elected a member of Council in 1914 and served as President from 1925 to 1926. For some time he was a member of the London University Appointments Board and acted as chairman from 1938 until 1945. He was also a Governor of the London School of Economics.

MR. W. E. BENBOW

We have also to record, with regret, the death, at the early age of 53, of Mr. William Edwin Benbow, who died suddenly in London on December 29. Mr. Benbow, who had been editor of our contemporary, *Iron and Steel*, since 1935, was a descendant of Admiral John Benbow (1653-1702) and was born in June, 1900, at Dartford, Kent. In 1917, he commenced his technical career in the metallurgical laboratory of Vickers Limited, Crayford. In the following year, however, he left Vickers to take up the position of technical assistant to the chief draughtsman at the aircraft production section of Hooper and Company, Limited. In 1920, Mr. Benbow was appointed senior assistant in the metallurgical laboratory of J. and E. Hall, Limited, Dartford, where he was engaged on work concerned with foundry control, the testing of engineering materials and the investigation of metallurgical problems associated with refrigeration.

He remained with J. and E. Hall until 1928 and in that year left the works and became a technical journalist. After spending a year on the staff of *The Tramway World*, he entered the service of the Louis Cassier Company, Limited, as assistant editor of *Iron and Steel Industry* and *Metal Industry*. In 1933 he became the first editor of *The Welding Industry*, now *Welding and Metal Fabrication*, and in 1935 was made editor of *Iron and Steel Industry*, subsequently known as *Iron and Steel*. Mr. Benbow was a good linguist, speaking French and German and possessing a working knowledge of several other European languages. As general editor of the recently-published book, *Steels for Modern Industry*, he provided, at short notice, the important introductory chapter, which is a thoughtful and well written review of the subject. Mr. Benbow was elected a member of the Iron and Steel Institute in 1935 and was also for a number of years a member of the Institute of British Foundrymen and of the Institute of Welding.

★ ★ ★

We also regret to record the deaths of the following: MR. C. H. NUNN, A.M.I.E.E., manager of the transformer works of the General Electric Co. Ltd., Magnet House, Kingsway, London, W.C.2, on December 22, at the age of 56. MR. A. W. HONEYMAN, commercial manager of the Carron Company, Carron, Stirlingshire, on December 26, after 50 years of service with the company. MR. J. E. HODGKIN, chairman of Darlington Wire Mills, Skerne Works Ltd., and Premier Radiator and Engineering Co. Ltd., at Hamsterley, Durham, at the age of 78. MR. HAROLD STEVENS, O.B.E., secretary of Short Brothers, Ltd., Sunderland, at Sunderland. MR. PATRICK DANIELSSON, of the project department of the Atlas Diesel Co., Stockholm, at the age of 65.

DEFENCELESS SEA DEFENCES

LESSONS OF THE 1953 FLOODS

THE causes of the disastrous flooding of the low-lying areas of the East Coast of Great Britain (and of the even more disastrous flooding experienced in Holland and Belgium) during the night of January 31-February 1, 1953, and the steps since taken to repair the sea defences are a subject of vital importance if a recurrence, with its attendant loss of life and damage to property, is to be prevented or at least reduced in intensity. The diversity of the problems involved soon became apparent at the North Sea Flooding Conference held at the Institution of Civil Engineers on December 16 and 17, 1953, when twelve papers were presented to an audience which included engineers from Holland, Belgium and the United States. Mr. J. V. Spalding, M.I.C.E., who presented the first paper, entitled " A General Survey of the Damage done and the Action Taken," stated that between the late afternoon of January 31 and the morning of February 1 approximately 1,000 miles of sea defences and tidal embankments were attacked in turn, resulting in over-topping and breaching at more than 1,000 sites.

The consequent flooding caused the loss of over 300 lives and the flooding or damaging of over 24,000 houses, many beyond repair. Public utility services were interrupted and 12 gas-works, two generating stations and many smaller stations and sub-stations suffered varying degrees of dislocation. Water-supply services were interrupted and some sources became contaminated with salt water. Sewage-disposal plants were affected. The roads and railways also suffered, with 11 arterial and numerous lesser roads rendered impassable and more than 200 miles of railway put out of action. Nearly 50,000 tons of filling and ballast were used for reinstating the track. It is estimated that nearly 13,000 cattle, sheep and pigs and 34,000 poultry were destroyed, while 160,000 acres of flooded land required the distribution to farmers of 100,000 tons of gypsum to restore the clay lands damaged by salt.

NORTH SEA SURGES AND METEOROLOGICAL ASPECTS

Information on the history and causes of flooding along the shores of the North Sea, and on the meteorological conditions favourable to the building-up of a surge, was contained in two papers entitled " Storm Surges on the East Coast of England " and " Some Meteorological Aspects of North Sea Floods with Special Reference to February, 1953," by Commander W. I. Farquharson, R.N. (Retd.), and Mr. S. M. Peters, B.Sc., respectively. Surges in the North Sea are no new phenomenon ; records show that a series began in the year 1086, with a devastating flooding in 1099 when, it was stated, 100,000 deaths occurred. The last storms of the series were in 1421 and 1446, in each of which the loss of life was also estimated at 100,000.

In more recent times and since organised official weather charts began, severe flooding in London occurred in 1875, 1877 and particularly in 1881, when the spring tide reached a height not subsequently exceeded until 1928. In 1897 a vigorous depression centred near the Orkneys and moved in a south-easterly direction towards Denmark, giving rise to northerly gales over almost the whole of the North Sea and causing a surge which breached the sea defences of Essex, including those of Foulness and Canvey Island. Large surges also occurred in January, 1916, when a deep depression moved similarly in a south-easterly direction across to Denmark. This depression caused widespread flooding in Holland and led to the establishment of the Dutch warning service for storm surges.

The meteorological conditions prevailing at the time of the 1953 surge were very similar to those prevailing at the times of the 1897 and 1916 surges. A vigorous depression approached from the north west, its centre crossing the North Sea in a south-easterly direction approximately on a line between the Orkneys and Denmark. Such a depression is able to raise the surface level of the sea and it is estimated that a drop in barometric pressure of about 30 millibars at any particular place will cause, under static conditions, a rise in sea level of about 1·0 ft. As the depression passed across the North Sea it gave rise to a northerly wind with a westerly element which rose to gale force and over, causing the sea to pile up before it and prevailing as far down as the English Channel.

Although tidal researches have not yet fully explained the origin of large storm surges entering the North Sea, they have shown that such surges may be developed when the speed of an associated depression reaches a critical value. If the winds over limited areas of the North Sea are appreciably different from the mean wind over the whole area, the effect of a main surge may be modified, and in such limited areas the local slope of the sea surface is indicated by theory to be proportional to the square of the local wind speed. The effect of a local wind is almost instantaneous and is inversely proportional to the depth of water. It is thus greatest in shallow water, where part of a surge may originate from interaction between a travelling surge wave and a tidal wave.

As the 1953 surge travelled down the coast, its elevation built up from 5·0 ft. at the Tyne to 7·5 ft. at Immingham and 9·75 ft. at King's Lynn, the greatest build-up occurring off the coasts of Holland and Belgium. The crest of the surge arrived 3½ hours to 4 hours after the time of high water for these places. Conceivably, therefore, there could have been a far more adverse combination of circumstances than actually happened, had the two effects been simultaneous. Commander Farquharson estimated that the levels of 11·5, 13·0, 16·5 and 19·8 ft. O.D. (Liverpool) attained at the Tyne, Tees, Immingham and King's Lynn, would otherwise have been 14·0, 16·5, 21·5 and 25·0 ft. respectively. During the discussion on the possibility of the peaks of a surge and tide coinciding, it was suggested that the imposing of the flow caused by the one on the flow caused by the other would increase friction, and therefore tend to reduce the height which would otherwise result, thereby causing a flattening of the surge as a whole as it passed any given point.

The conclusions arrived at for purposes of comparison were that, on the open coast, the highest water levels reached were not greatly in excess of those which had been reached in earlier years. In the Wash and the Thames estuary, the water levels reached were more than a foot above any previously recorded. In the upper tidal reaches of such rivers as the Humber and the Thames, the water levels reached were not as high as those previously recorded. The 1953 surge was unique, however, because it was the only one which raised sea levels to record heights along the whole of the East Coast from the mouth of the Tees to the Straits of Dover; also, at Sheerness, an elevation of 6 ft. or over was maintained for a continuous period of 15 hours, although the interval between successive high-waters is, at all times, less than 12½ hours.

FAILURE OF SEA DEFENCES

It was stated during the discussion at the Conference that flooding started on the Northumbrian coast at about 3.30 p.m. Thus, since the surge moved southwards, almost all the damage was done during the hours of darkness. As Mr. Spalding wrote: " Not only were there no eye-witnesses, but for the first few weeks every engineer concerned was so preoccupied with the work of closing breaches that he had little time to consider how they were caused." The causes of failure, therefore, have necessarily been deduced subsequently.

In the paper on " Soil Mechanics Studies of Failures in the Sea Defence Banks of Essex and Kent " presented by Dr. L. F. Cooling and Mr. A. Marsland, M.Sc., the possible causes of the failure of earthen banks were stated to be " (*a*) erosion of the seaward face by wave action ; (*b*) erosion of the landward face, followed by over-topping ; (*c*) slipping or slumping of the landward face caused by seepage through the bank ; and (*d*) building-up of water pressure in pervious layers underlying the bank, leading to complete failure of the bank." Dr. Cooling concluded that in the majority of cases the prime cause of failure was seepage, which usually commenced at the toe of a bank where the outward flow is concentrated, and works progressively backwards into the slope and is eventually followed in the later stages by complete slipping of the landward face. Over-topping, he considered, was most damaging as a second stage following the occurrence of shallow slips consequent upon seepage.

In his paper on " Damage to the Kent Coastline and Restoration Works," Mr. G. C. Crowther, O.B.E., stated that it was his " opinion that, in general, the failures were caused by the water flowing over the top of the defences, which . . . were mostly earthen walls with stone facing; this overflow produced a scour on the landward side of the wall to such an extent that the wall itself and the material at the base of the wall were scooped out and carried back into the marsh, with the result that the front face of the wall eventually collapsed, carrying the facing backward so that a complete breach occurred. The water then poured through the gap and produced larger scour holes at the landward toe which interfered generally with the stability in the area ; and on the return of the water through the breaches at low-tide period, this scour was enhanced and the breaches widened."

There was no unanimity of opinion as to what may have been, in general, the prime cause of failure, but the need for research to assist future design was expressed, not only by several of the speakers and those taking part in the discussions, but also by Lord Waverley, F.R.S., chairman of the Committee on Coastal Flooding, who said that we know the effects but did not know what would happen with a different combination of conditions.

REPAIRS AND COSTS

Other papers presented were entitled " Design of Sea Defence Works in Relation to Height of Tide and Degree of Exposure," by Mr. C. H. Dobbie, M.I.C.E. ; " The Incidence of Storm

Surges as a Factor in the Design of Coast Protection Works," by Mr. J. Duvivier, M.I.C.E.; "Sea Defence Works on a Sandy Eroding Coast with Scanty Littoral Drift," by Mr. S. W. Motts; "Damage to the Essex Coastline, and Restoration Works," by Mr. E. L. Snell, O.B.E., A.M.I.C.E.; "Sea Defences in the Wash and Estuary of the Great Ouse in Relation to the Tidal Surge of the 31st January, 1953," by Mr. W. E. Doran, O.B.E., M.I.C.E.; "Flood Damage in Norfolk and Suffolk," by Mr. K. E. Cotton; and "Damage and Remedial Operations on the Lincolnshire Coast," by Mr. F. H. Tomes, O.B.E., M.I.C.E.

Approximately £14 million has so far been expended on the restoration of sea defences and effecting improvements, the latter accounting for about half of the total expenditure and including such work as the improvement of the drainage of adjacent agricultural land. The sea-defences at the present time are now in better shape than they were in January, 1953. To quote from Mr. Duvivier's paper: "some monumental works have been built at a rate of output which has only been equalled once before, namely in the days of the Mulberry harbours." Mr. Duvivier also gave certain figures of cost per lineal foot for the new sea walls. The Sea Palling-to-Waxham wall, 12,500 ft. in length and complete with sand-filling between the wall and the dunes, amounts to £26 per foot run; the Horsey-to-Winterton length has cost £29 per foot run. These rates can, of course, only be taken as approximate, as other works, of which there are a great number, have cost less and some a great deal more per foot run to construct.

★ ★ ★

REGIONAL INFORMATION SERVICES

A Co-operative Scheme for Industry

The formation of organisations designed to foster the interchange of technical and commercial information is usually welcomed by those responsible for keeping abreast of new developments in industry. The Co-operative Industrial and Commercial Reference and Information Service (C.I.C.R.I.S.), formed at the instigation of the Acton Borough Librarian, Mr. R. D. Rates, has been in operation for two years, and has established itself as an active and live organisation for the collection and dissemination of information in the West London Area.

With the local Public Library as an administrative centre, it has won the co-operation of 93 of the largest firms in the area, and has the support of the Board of Trade and the Department of Scientific and Industrial Research, as well as that of the local Chambers of Commerce and Research Associations. In addition, bodies such as the Hispanic and Luso-Brazilian Councils, the U.S. Patents Office (through the Library of Congress), the American Industrial Information Service, and all information services of the Dominions and Colonies are assisting in the scheme.

Those co-operating have pooled their information resources, and work already accomplished includes the preparation of a union list of periodicals and similar lists of annuals, directories and dictionaries. The benefits to be derived from the concentration of information on a regional basis are considerable, and the success of the present scheme may well encourage firms and librarians in other areas to form their own co-operative information services. Further details may be obtained from the Secretary, C.I.C.R.I.S., Central Public Library, High-street, Acton, London, W.3.

THE NORTH BRITISH LOCOMOTIVE CO.

DESIGN FOR A COAL-BURNING GAS-TURBINE LOCOMOTIVE

In a book published to commemorate a double anniversary, the North British Locomotive Company, Limited, give preliminary details of a coal-burning gas-turbine locomotive which they are designing and building jointly with C. A. Parsons and Company, Limited, for tests on British Railways. The problem of fly ash damaging the turbine blades is being circumvented by employing an "exhaust heater"—a tubular heat exchanger in which the incoming air from the atmosphere is heated.

The air is delivered under pressure through the tubes of the exhaust heater, where it reaches a temperature of nearly 1,300 deg. F. It then drives first a turbine which is coupled to the compressor, and secondly the power turbine. The air is then fed to the combustion chamber, where pulverised coal is blown in and burns with a fierce flame. Thereafter, the hot gases are, presumably, delivered to the "exhaust heater," though this is not stated in the book. However, the fuel, clearly, is introduced after the air has passed through the turbines.

DIRECT DRIVE

An electric or hydraulic transmission is not employed. The power turbine is geared directly to the driving wheels. The torque generated by the turbine is greatest at starting – a characteristic admirably suited to railway traction.

The trials of the prototype, which has been ordered by the Ministry of Fuel and Power, will be awaited with great interest by railways throughout the world, since, if the design is successful, it will offer a new form of motive power to those railways which, like British Railways, cannot command cheap hydro-electric power, are hesitant about the immense capital cost of wholesale electrification, and are not happy about using imported oil in either Diesel or gas-turbine locomotives. It is expected that the coal consumption of the coal-burning gas-turbine locomotive will be only half that of a conventional steam locomotive. On railways where train heating is necessary the relative economy will be even greater, since the exhaust heat of the gas turbine can be used in a boiler for this purpose. And except where a train-heating installation is employed, the locomotive will require no water.

An illustration of a model of the prototype shows it to be a locomotive with two sets of six small wheels, arranged like those of existing Diesel-electric locomotives, but having the power unit slung under the chassis in the middle. Assuming that all the wheels are used for traction, the locomotive will evidently be comparable in power to the two oil-burning gas-turbine engines already in service on British Railways.

28,000 LOCOMOTIVES

The two anniversaries, which were celebrated last year, were the 50th of the formation of the company and the 120th of the completion of the first locomotive built by the oldest of the incorporated firms. The three Glasgow firms which were amalgamated in 1903 were Neilson, Reid and Company; Dübs and Company; and Sharp, Stewart and Company, Limited. The latter had the longest history of the three. It had been operating for some years in Manchester in the iron business when Richard Roberts, of textile-machinery and machine-tool fame, joined as a partner about 1822. He built the road locomotive "Experiment" in 1833, and subsequently the firm built many locomotives, including about 600 of the famous Sharp "singles."

In 1888 Sharp, Stewart and Company moved to Glasgow, where they took over the principal interest in the Clyde Locomotive Works—a business founded by Walter M. Neilson after a disagreement with his partner in the firm of Neilson and Company. This firm (known as Neilson, Reid and Company at the time of the 1903 amalgamation) dated back to about 1836. The manager from 1858 to 1863 was Henry Dübs. In 1864 Dübs built his own works and, incidentally, was the first engineer (it is said) to employ women as tracers in a drawing office. William Lorimer joined the business in 1864, and his grandson, Mr. W. D. Lorimer, is to-day joint managing director of the North British Locomotive Company, thus preserving an unbroken family connection of 90 years.

The amalgamation in 1903 created the largest firm of locomotive builders in Europe, with 8,000 employees and a works area of 60 acres. The combined firms have built nearly 28,000 locomotives, almost a third of which have been for British railways. To-day about 90 per cent. of the production is exported. The output includes Diesel-electric, Diesel-hydraulic and electric locomotives, and the company's associated businesses produce steel castings (the Carntyne Steel Castings Company, Limited); machine tools (Henry Pels and Company, Limited); as well as Lima excavators built under licence, and a special marshland tractor built to the designs of Mr. J. A. Cuthbertson, of Biggar. An admirable apprentice scheme is in operation.

★ ★ ★

MINISTER'S MESSAGE TO ATOMIC ENERGY STAFF

In accordance with the recent Order in Council, Ministerial responsibility for atomic energy passed on January 1 from the Minister of Supply to the Lord President of the Council. Mr. Duncan Sandys, the Minister, issued the following message to all members of the staff of the headquarters and establishments of the Atomic Energy Organisation.

"Before you leave the Ministry of Supply and transfer to the new organisation, I wish warmly to thank you for the contribution which all of you have made, individually and collectively, to the development of atomic power for both military and civil purposes. Together with your colleagues in America, many of you took part in the design of the first atomic bomb during the war. Since then, working on your own, you have developed, proved and brought into production, British atomic weapons of more advanced types. At the same time you have made remarkable progress in applying the forces of nuclear fission to peaceful ends, thus opening up to this and future generations an ever expanding prospect of material betterment.

In the whole history of mankind through the ages, there have been comparatively few discoveries of a really fundamental character. Among these will certainly rank the discovery of how to release and exploit the unbounded energy which, since the dawn of time, has remained hidden in the nucleus of the atom. You have a right to feel very proud of having played some part, whether great or small, in these momentous achievements."

STEEL PRODUCTION IN EUROPE

A Record Year

Figures issued by the Economic Commission for Europe indicate that the record steel production of 1952 was probably exceeded in 1953 by a small margin. The estimated figure is 75,000,000 metric tons from all European countries (not including the U.S.S.R.), which is a 1 per cent. increase over the totals for 1952.*

In the United Kingdom, production in each of the first eleven months of 1953 exceeded the previous records, the estimated increase for the whole year being 7 per cent. The actual rate of production was higher than this figure would indicate as there were 53 weeks in 1952 as against 52 in 1953. Allowance for this gives an estimated increase of 9 per cent. Production in Czechoslovakia increased by about 17 per cent., in the Netherlands by 24 per cent., and in Austria by 18 per cent. It is the increases in these four countries which offset the decreases in France, Belgium and Luxembourg (about 10 per cent.), and Western Germany (2 per cent.). Of the seven countries belonging to the European Coal and Steel Community, the only one showing an increase is the Netherlands (the smallest producer of the seven), and all taken together show a decrease of 5 per cent.

Production in the U.S.S.R. and also in the United States is again expected to be a record. In the former, a total of about 38,000,000 metric tons is estimated, which would be an increase over 1952 of 10 per cent. In the United States the output is expected to be about 102,000,000 metric tons, an increase of 7 per cent. when compared with 1951 figures. (The prolonged steel strike in 1952 does not allow a true comparison for that year.) Japanese production for 1953 may reach 7,600,000 metric tons, which is approaching the record and is an increase of 9 per cent. on 1952.

Imports to both the United Kingdom and Western Germany have fallen back from the very high levels reached at the end of 1952. At that time they were about 3 and 18 times, the average figure for 1951, respectively. By September, 1953, they had fallen to 1·6 and 7·3 times the averages for the first nine months being 2·2 and 10·5 times, approximately. Sweden and Switzerland also show a decline since 1951 (though both increased a little during the year), while the Netherlands show an increase of about 7 per cent.

Exports from France, Belgium and Luxembourg show a decline during the third quarter of 1953, and in September were only about 80 per cent. of their 1951 figures. Western Germany and the United Kingdom have held their position, with the former showing a slight tendency to improve. When the net exports of 20 countries are considered, the second quarter shows an increase of 40 per cent. over the first quarter and over 1952. This reflects the rise in exports to overseas markets, and also the fall of exports to Europe from the United States and Japan.

Imports of iron ore to West Germany and Italy decreased by 9 and 33 per cent., respectively; those to Belgium and Luxembourg showed no significant change, while those to the United Kingdom increased by 19 per cent.

Scrap imports to Italy rose 27 per cent. and to the United Kingdom 6 per cent. German exports fell 14 per cent. The figures available seem to show that more scrap is being used in steelmaking furnaces and less in pig-iron furnaces than formerly.

* *Quarterly Bulletin of Steel Statistics for Europe*, from sales agents for United Nations publications (7*s.* 6*d.*).

FAILURE OF A HIGHWAY BRIDGE

A WARNING TO ROAD HAULIERS

The failure of bridges in the United Kingdom is a rare event, but during last April, under the passage of an abnormal road load, the Parkhouse-road overbridge collapsed on to the railway at Ardrossan in the Scottish Region of British Railways. The report of the Inspector of Accidents, on the circumstances of the accident, which occurred on April 26, 1953, has now been published,* and contains some valuable information on the strength of small highway bridges. In this particular case, the bridge failed simply under an excessive load without any other contributory cause (such as an incipient failure due to a fault in the materials). Calculations made after the accident show a remarkable degree of agreement between the load then on the bridge and the strength of the bridge as estimated by a simple theory from the dimensions of the component girders and the strength of the cast iron, as determined from tests on samples taken from the failed structure.

The overbridge was constructed in 1878 with masonry abutments and wing walls and with a superstructure of cast-iron girders and floor plates. Loose sand filling was placed over the floor plates and the road surface was finished with a tarmac covering 4 in. thick. No renewal, alteration or strengthening of the main structure had been made since it was built.

The bridge was set on the skew with a square span across the railway of 26 ft.; the effective span of the principal load-carrying girders, which were set square to the abutments, was 27·5 ft. The roadway was 20 ft. wide with pavements on either side, giving 31 ft. clear between the parapets, which were carried on skew girders. These also supported the flying ends of those load-carrying longitudinal girders which did not reach the far abutment. Recent inspection of the bridge had shown that both the abutments and the superstructure were sound.

The load comprised an 84-ton ship's crankshaft complete with bedplate which was being carried on a three-axle 12-wheeled trailer hauled by a tractor. The four front wheels were mounted in pairs on separate axles each free to swing about its centre on a trunnion. Similarly, there were separate axles for each pair of eight rear wheels, all of which were fitted with twin 180 × 771 mm. solid-rubber tyres. They gave a loaded bearing area per wheel of approximately 14 in. width by 7 in. in length.

The deck failed when the rear wheels of the trailer had reached the middle of the bridge; the total load on the rear axles was estimated to be 70·15 tons, and this was then the only live load on the bridge deck, the tractor and the leading wheels of the trailer having already moved off the deck. The speed of the vehicle was given as being 1 mile per hour, every caution being taken as it was known that the load was in fact excessive for the bridge.

Examination of the failed bridge showed that six of the principal girders lying square to the abutments, and which would have been chiefly concerned in supporting the load, failed at mid-span directly under the rear axles.

Examination of test pieces cut from one of the girders close to a fracture at the centre of the span showed that the girders were "well made and true to section, free from blow holes, sand inclusions and general surface defects." Analysis showed that the cast iron was typical of the material used for heavy castings at the time of the construction of the bridge, the formation being a perfectly sound soft grey iron with a graphite pearlite matrix. Mechanical tests gave an average tensile strength of two pieces as 8·55 tons per square inch and a failing stress in bending of 19·8 tons per square inch.

From an analysis of the distribution of the load on the bridge deck, and from the depth of filling above the neutral axis of the girder, it was estimated that the total wheel load on the girder bearing the greater part of the weight was 38·75 tons and that this load was spread uniformly over a length of 9 ft. 4 in. Considering the girder as simply supported, the maximum bending moment, including dead load and an allowance of 10 per cent. for impact, was found to be 3,689 tons-in. Calculating from this figure the maximum tensile stress was found to be 8·72 tons per square inch, and the maximum compressive stress in bending, 19·11 tons per square inch. These figures, without the allowance for impact, are 8·11 and 17·73 tons per square inch, respectively. Comparison with the measured strength of the cast iron, noted above, shows how close was the load to that likely to bring about failure.

It was made clear in the report that constant warnings had been issued by the Divisional Road Engineer indicating that the bridge at Ardrossan was in fact not capable of carrying the heavy loads which often had to be carried over it, but, it was also noted, if heavy loads were to be moved by road in the area south-west of Glasgow, then it was inevitable that they should be taken across this bridge.

* *Report on the Collapse of No. 2 Parkhouse Road Overbridge at Ardrossan in the Scottish Region: Railway Accidents.* H.M. Stationery Office. [2*s.* net.]

★ ★ ★

SHIPBUILDING PROSPECTS

Steel Supply Difficulties Persist

During 1953 new orders for merchant vessels placed in shipbuilding yards in the United Kingdom totalled about 500,000 gross tons. This was only one-third of the tonnage ordered in 1952 and one-eighth of that ordered in 1951.

In a recent statement, Mr. J. W. Elliott, C.B.E., President of the Shipbuilding Conference, points out that changed world conditions after the war in Korea and the fall in freights and in the value of ships mean that the placing of orders for new ships at high prices is a thing of the past, and only by increased output and by more economical and expeditious overtaking of existing orders will further orders be stimulated. Against the background of declining orders, which is a world-wide feature, there is, moreover, the emergence of keen competition from Continental countries, including Western Germany, for the smaller volume of work now available.

Mr. Elliott also states that the vexed question of difficulties in steel supplies has persisted throughout the year and the total output of launches has thereby been maintained well below this country's capabilities in this direction. He earnestly hopes, therefore, that the steel supply problem, particularly in so far as ship plates are concerned, will be largely solved during the present year. Firms building oil tankers, which make up more than half of the orders on the books now totalling 5¾ million gross tons, are assured of work for two or three years ahead, in some cases. On the other hand, the large number of firms which construct the many other types of shipping are actually seeking new orders to replace work now on hand and soon to be completed.

Book Reviews

Factory Health, Safety and Welfare Encyclopaedia. By C. CONWAY PLUMBE, B.Sc. *National Trade Press, Limited, Tower House, Southampton-street, London, W.C.2.* (30*s.*)

Every factory owner, works manager or industrial executive of any grade knows that the operations which he supervises, or controls, are the subject of a mass of official regulations. He is probably familiar with those applying to the particular type of industrial activity with which he is concerned, but the continuing development of manufacturing methods and plant may at any time confront him with conditions subject to regulations with which he has not previously been concerned.

He may, and probably will, receive assistance from the factory inspectorate, which, in general, has ceased to be regarded as "a technical police force," but this body may not be in a position to afford immediate assistance and this publication, which surveys the whole field covered by its title, might profitably find a place in every industrial establishment. Although Mr. Plumbe is a former H.M. Superintending Inspector of Factories, his book does not pretend to present official interpretations of the various factory regulations – that is a matter for a law-court – but those concerned are not likely to go far wrong if they follow his advice and instructions.

Factory regulations, which continue to grow in bulk and complexity, have, in the past, been mainly concerned with health and safety, but are tending more and more to encroach on the somewhat indefinite field known as welfare. The Secretary of State now has power to make regulations governing the supply of drinking water; washing facilities; accommodation for clothing; rest rooms; arrangements for preparing, heating or taking meals; and canteens. Some of these matters clearly fall within the sphere of health regulations, as for instance, those relating to washing facilities. No standard has been laid down for industry in general, but the information given about the elaborate regulations applying to the pottery industry will be a guide to any works manager contemplating the provision of improved facilities.

Although welfare is receiving ever-increased attention in these introspective days, it is with health and accidents that the works executive is most closely concerned, and the encyclopaedic arrangement of this book will be of material assistance in giving specific information under such headings as cranes; ladders; static electricity; oxides of nitrogen; and hundreds of others. In some special industries, the possibility of industrial poisoning is the dominating consideration behind factory regulations, but in industry as a whole their purpose is to guard against mechanical accidents. That the regulations, or rather their applications, have been successful is strikingly shown by Mr. Plumbe's remark that "the factory worker, with only very few exceptions, is definitely safer at work than on his way there."

In an engineering factory, moving machinery and electrical plant and circuits would appear to be the obvious sources of danger and great attention is paid to their guarding and isolation, but actually they are far from being the main sources of accidents. In 1950, in the heavy engineering industry (excluding motor vehicles), 8,206 accidents were due to "power-driven machinery and transport," but 11,239 were due to "handling goods, materials and objects," and 2,563 due to "stepping on or striking against objects." There were other non-machinery accidents and, of a grand total of 38,178, only the 8,206 quoted above were machinery and transport accidents. Falls from a height or on the level were responsible for 3,531 and Mr. Plumbe states that "one bad fall happens somewhere at work every five or six minutes." These are by no means all from ladders or gangways; very many are due to tripping over objects, attributable frequently to bad lighting or untidy shops. Bravado skylarking and unsuitable footwear are important contributory causes which are within the control of the workpeople themselves. The irresponsibility of operatives is a hampering phenomenon with which works managers striving for safe shops will probably always be faced, but in as far as they can circumvent it, or render it harmless, they will come the nearer to achieving their ends. Mr. Plumbe will prove a valuable guide on their weary way.

The Heating and Ventilating Industry: Year Book for 1953. *Technitrade Journals, Limited, 8, Southampton-row, London, W.C.1.* (7*s.* 6*d.*)

This is the seventh issue of the year book of the heating and ventilating industry. As before, it has been compiled by the publishers in conjunction with the Association of Heating, Ventilating and Domestic Engineering Employers, 58, Victoria-street, London, S.W.1. It provides, in one compact volume, technical, contract and other trade information of value to architects, consulting engineers, surveyors and heating and ventilating contractors. Together with lists of member firms of the Association and of manufacturers' addresses, there are several articles by specialist contributors, an exhaustive bibliography of relevant articles published in various British technical journals during 1952, and official statements concerning agreements of service and labour relations.

The principal articles are concerned with panel heating, foreign heating and ventilating practices, developments in gas heating and hot-water supply and the modular principle in building. The section of model by-laws which discusses the prevention of waste, undue consumption, misuse or contamination of water, is printed in full. The published agreements include those made between the Association and the trade unions in respect of wages and working conditions for craftsmen, apprentices and other labour; and the daywork agreements reached with the contracts co-ordinating committee of H.M. Government and with the Royal Institution of Chartered Surveyors. The Standard Conditions of Trading, as devised by the Association, is also given in full.

Proceedings of the Fifth British Electrical Power Convention. British Electrical Power Convention, 16, Stratford-place, London, W.1. (10*s.* 6*d.*)

This book is a complete record of the proceedings of the fifth British Electrical Power Convention, which was held at Torquay in June, 1953, under the presidency of Sir John Hacking. The underlying topic of the presidential address and of the papers that were read was electricity and national prosperity. The papers included one on the general subject by Colonel B. H. Leeson, while eleven other authors dealt with industrial production and application, combined heat and electricity supplies, electricity and food production and electricity in agriculture and horticulture from more specialised viewpoints. A full account of the various discussions is also given and the whole forms a valuable record of an important gathering and a useful work of reference.

★ ★ ★

British Standards

The following publication has been issued by the British Standards Institution. Copies are available from the Sales Department of the Institution, 2, Park-street, London, W.1, at the price given after the title.

Tolerances for Mouldings in Thermosetting Materials (3*s.*, post free.)

A new specification, B.S. 2026, is concerned with tolerances for mouldings in thermosetting materials. A widely used practice has been to specify tolerances such as $\pm$ 0·005 in., for decimal dimensions and $\pm \frac{1}{64}$ in. for fractional dimensions for mouldings of plastic thermosetting materials. These figures, it is pointed out, are arbitrary and bear no relation to conditions peculiar to moulding technique. A system of standard tolerances for thermosetting mouldings has therefore been drawn up; this has a technical instead of an arbitrary basis. It should, however, be noted that the measurement of moulded pieces can never attain great accuracy on account of minor dimensional changes taking place during ageing. Tolerances to nearer than 0·001 in. are thus likely to be unrealistic because of these changes. Four classes of tolerance are provided for, ranging from the narrowest possible limit commensurate with closely-controlled and supervised processing at all stages of production, to wide variations where dimensions are not important. The relationship between the various classes is such that the widest tolerance is four times that of the closest, the other two classes being intermediate.

★ ★ ★

TRADE PUBLICATIONS

Chemical-Control Equipment for Water Treatment. Wallace & Tiernan, Ltd., Power-road, London, W.4, have issued an illustrated four-page leaflet giving brief particulars of the instruments and equipment that they produce for the treatment of water for drinking purposes and swimming baths, and for dealing with sewage effluents and trade wastes.

Lathe and Planer Tools. A leaflet showing standard shapes and sizes of the "Hypercut" high-speed steel butt-welded cutting tools recently placed on the market has been issued by Alfred Herbert, Ltd., Coventry.

Industrial Gloves and Protective Clothing. G. Waddington & Son, Ltd., Newland, Hull, have issued a brochure illustrating a wide range of leather industrial gloves, mitts, aprons, high-speed polishing mops, welders' leggings with spats, sleeves, etc. These products are marketed under the trade name "Furno."

Lighting of Westminster Abbey at the Coronation. Holophane, Ltd., Elverton-street, London, S.W.1, have sent us a handsome booklet describing the lighting of the interior of Westminster Abbey for the Coronation ceremony. This was an exacting task, which involved many special problems, and the way in which they were overcome is effectively described.

Switchgear and Motor Control Gear. Allen West & Co., Ltd., Brighton, 7, have re-issued their catalogue of switchgear and electric-motor control gear. Oil-break switchgear is listed with capacities up to 1,600 amperes at 11,000 volts, and control and starter gear for all types of electric motor. Overhead line gear and special-purpose switches are also dealt with.

★ ★ ★

BOOKS RECEIVED

History of Steam Road Vehicles. By DR. C. ST. C. B. DAVISON. *H.M. Stationery Office, Kingsway, London, W.C.2.* [3*s.* 6*d.* net.]

Dislocations in Crystals. By W. T. READ, JR. *McGraw-Hill Book Company Incorporated, 330, West 42nd-street, New York 36, U.S.A.* [5 dols.]; and *McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4.* [Price 36*s.*]

Brücken in Stahlbeton. By CARL KERSTEN. Vol. I. Platten- und Balkenbrücken. Eighth edition, revised by DR.-ING. CURT DEDERING. *Wilhelm Ernst and Sohn, Hohenzollerndamm 169, Berlin-Wilmersdorf, Germany.* [19 D.M. in paper covers, 22 D.M. bound.]; and *Lange, Maxwell and Springer, Limited, 242, Marylebone-road, London, N.W.1.* [33*s.* 3*d.* in paper covers, 38*s.* 6*d.* bound.]

Whitaker's Almanack, 1954. *J. Whitaker and Sons, Limited, 13, Bedford-square, London, W.C.1.* [Complete edition, 15*s.*; shorter edition, 7*s.* 6*d.*; library edition, with coloured maps, 30*s.*]

Analyse und Bewertung von Angestelltentätigkeiten. By HANS EULER and others. [12·50 D.M.]. **Der Altersaufbau der Belegschaft der Eisen- und Stahlindustrie in der Bundesrepublik Deutschland am 1 December, 1952.** Edited by H. EULER. [3·60 D.M.] *Verlag Stahleisen m.b.H., Breite Strasse 27, Düsseldorf, Germany.*

Introduction to Steel Shipbuilding. By ELIJAH BAKER III. *McGraw-Hill Book Company Incorporated, 330, West 42nd-street, New York 36, U.S.A.* [6 dols.]; and *McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4.* [42*s.* 6*d.*]

Textbook of the Materials of Engineering. By PROFESSORS HERBERT F. MOORE and MARK B. MOORE. Eighth edition. *McGraw-Hill Book Company Incorporated, 330, West 42nd-street, New York 36, U.S.A.* [6 dols.]; and *McGraw-Hill Publishing Company, Limited, 95, Farringdon-street, London, E.C.4.* [48*s.*]

The Engineering Outlook-1

RETROSPECT AND PROSPECT

II – RAW MATERIALS

ONE of the major uncertainties in the outlook for the engineering industries at present is the course of raw material prices. As a result of the break in prices which occurred in the middle of 1952, and its depressing effect on stock values, many companies have shown lower profits in 1953. While, moreover, manufacturers are not satisfied that prices have yet reached bottom, they tend to keep stocks as low as possible, and this in turn affects their attitude to outlay on plant and machinery. Apart, therefore, from any fears of marketing difficulties or the possible consequences of an American slump, a general air of caution is to be expected. It is unfortunate that manufacturers should be so influenced by the effect of raw material prices on profits. In the inflationary post-war world, until 1952, windfall gains from rising stock values could be relied upon almost unfailingly, and this tended to give a rather illusory impression of the course of profits. Real profits, of course, are not based on the margin between selling price and original cost, but on the difference between selling price and replacement cost ; so that, if raw materials rise in price, and stocks have to be replaced at higher cost, real profits actually fall although book profits may be very much higher. Conversely, in 1953, though book profits may have fallen, real profits have increased in many cases.

Perhaps the only sound reason for deploring a fall in raw material prices is that it brings about a fall in the income of the primary producing countries, which in turn affects British exports of engineering goods. The corrective for this is not, however, a rise in the prices of raw materials, but an increase in the efficiency of production methods which will enable the countries concerned both to enjoy a higher standard of living and to sell their goods more cheaply in world markets. The outlook for these markets thus depends more upon the course of foreign investment in them, particularly by the United States, than upon the trend of raw material prices. On the longer view, the British engineering industry has everything to gain from stable low prices of materials. There can no longer be cause for complaint that fluctuating prices make it impossible to give firm quotations. In the past, inability to do so has often been held responsible for the loss of vital export orders to competitors who were able to insure themselves against or insulate themselves from such fluctuations. All the non-ferrous metals have now been freed from control ; tin was freed in 1949, lead in October, 1952, zinc in January, 1953, and finally copper in August, 1953. Manufacturers can now, therefore, make use of hedging facilities to protect themselves against price fluctuations ; and whereas, in the old days of official bulk purchase, they often had to obtain their metals from the Ministry of Supply at prices substantially higher than those paid by their competitors, they now pay the prices ruling in world markets.

TRENDS IN NON-FERROUS METALS

It would be rash at present to make any assumptions about the future trend of raw material prices, but there are some slight indications that they may be hardening a little. As may be seen from Fig. 1, above, the Board of Trade indices of the prices of materials used in engineering, while still below the peak of July, 1952, were appreciably higher in November, 1953, than the low levels of June, 1953. Fig. 2 shows that, of all the non-ferrous metals, only aluminium was not higher in price in November than in August, 1953. All except nickel – the production of which could not quickly be greatly expanded to meet defence requirements – are still, of course, far below their former peak prices. Lead, for example, has fallen by 45 per cent. since January, 1952 ; copper in November, 1953, was 16 per cent. lower than in August, 1942 ; tin, 36 per cent. lower than in February, 1952 ; and zinc, 59 per cent. lower than in March, 1952. The recent strength of non-ferrous metal prices has been due at least in part to some exceptional features. Thus Continental buying on the London metal market has reduced the stocks of lead and zinc in the United Kingdom to a temporary low level. Although there is little in the way of firm proof, this Continental buying is generally believed to have been due to heavy sales behind the Iron Curtain. The price of copper has been enhanced by the determination of the Chilean producers, who are the largest exporters, to hold out for the ruling market price in their negotiations for the disposal of their accumulated copper stocks, amounting to 140,000 tons.

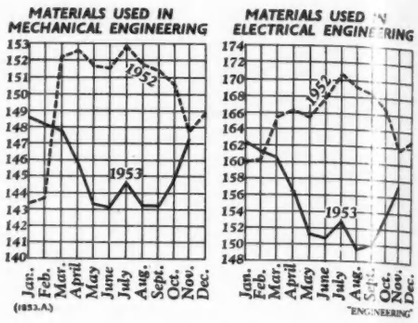

MATERIALS USED IN MECHANICAL ENGINEERING
MATERIALS USED IN ELECTRICAL ENGINEERING
1952
1953
Jan. Feb. Mar. April May June July Aug. Sept. Oct. Nov. Dec.

Fig. 1 United Kingdom wholesale price index numbers (1949 = 100) for materials in engineering.

Apart from these exceptional features, the markets for the non-ferrous metals are generally weak, and they could deteriorate considerably if industrial activity in the United States fell off even slightly, or if the United States Government decided to throw their stock-piles on world markets. Even at the present level of industrial activity in the United States, it is improbable that, after absorbing the Chilean surplus, the United States will be able to import the whole of the Chilean output of copper, so that substantial quantities should be released on the European market. The United States Government will obviously exercise great caution in reducing excessively large stock-piles, but the very knowledge of their intentions to do so is enough to depress markets. At the second session of the United Nations Tin Conference, at the end of November, the United States delegation stated that their Government would have about 40,000 tons of tin in excess of their strategic requirements, and that the Government were studying the question of its disposal " with the aim of minimising the effect on the tin market." One of the advisers to the delegation declared, moreover, that the tin would be offered for sale to industry during 1954.

Taking a longer view, the prospects for the non-ferrous metals are generally healthy ; there is, for example, little cause for pessimism about the outlook for aluminium, the market for which has been particularly depressed. In the United Kingdom, all the large aluminium-producing companies have had to pay off many of their workpeople, and short-time working is common

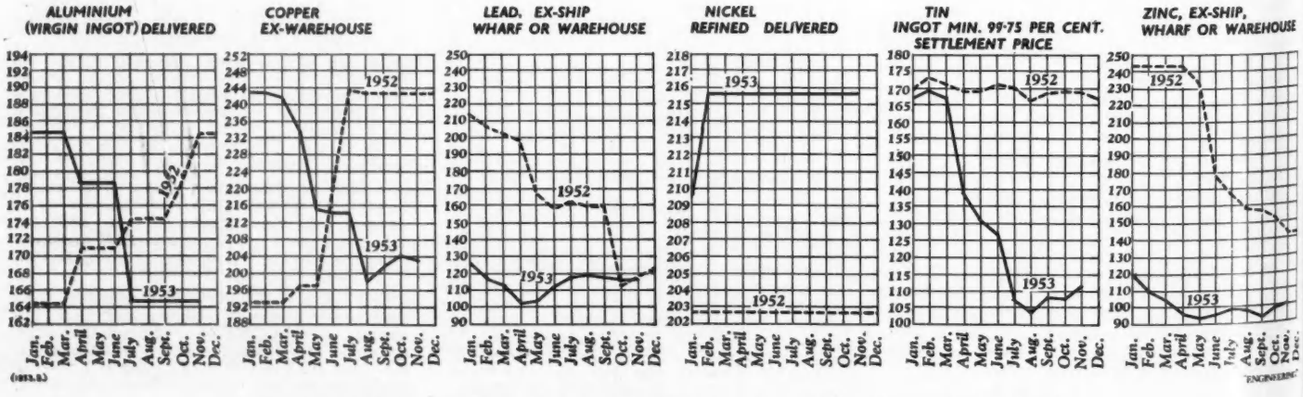

ALUMINIUM (VIRGIN INGOT) DELIVERED
COPPER EX-WAREHOUSE
LEAD, EX-SHIP WHARF OR WAREHOUSE
NICKEL REFINED DELIVERED
TIN INGOT MIN. 99·75 PER CENT. SETTLEMENT PRICE
ZINC, EX-SHIP, WHARF OR WAREHOUSE
1952
1953
Jan. Feb. Mar. April May June July Aug. Sept. Oct. Nov. Dec.

Fig. 2 Wholesale price index numbers for principal metals (1949 = 100) in 1952 and 1953.

throughout the industry. In the United States, the slump in aluminium sales did not occur till late in 1952, and it is expected that deliveries to industrial consumers in 1953 will achieve a record of 1·7 million short tons. This is 350,000 tons more than in 1952 and does not include deliveries to the stock-pile. Orders for November and December, 1953, fell off substantially, those for the latter month totalling only about one-third of those for the former. In consequence, the Kaiser Aluminium and Chemical Corporation dismissed 600 employees from their rolling mills at Trentwood in November. Expansion programmes in the aluminium industry have also had to be curtailed, at least temporarily. Olin Industries and the Wheland Company, for example, partly because of the more restrictive credit policy of the United States Treasury, have already declared themselves unable to carry out their planned extensions to primary capacity.

NEW APPLICATIONS OF ALUMINIUM

The low demand for aluminium in the United Kingdom in the early part of 1952 was due to the simultaneous occurrence of three factors, namely, the reduction in armament production, the fall in motor-vehicle output, and competition from steel. In the building industry, which, together with the motor-vehicle industry, accounts for about 60 per cent. of the consumption of aluminium in the United Kingdom, many users turned to aluminium when steel was difficult to obtain; now that steel is plentiful at relatively favourable prices aluminium has lost some ground. In the same way, more plentiful supplies of tinplate have displaced aluminium in the manufacture of containers. In the second half of 1952, the high level of production of motor vehicles helped to sustain the demand for aluminium in the United Kingdom, whereas the fall in motor-vehicle output in the United States has presumably helped to depress it in that country.

The present high rate of output of motor vehicles in the United Kingdom is based upon exceptional sales to the home market, which may collapse quite suddenly when the arrears of orders are worked off. This may result in a further temporary fall in the demand for aluminium, but the large number of new applications for this metal should, in the end, make for greatly increased consumption. In particular, the introduction of Aircomatic welding has opened up a large field of application, especially in shipbuilding and in the railway rolling-stock industries. The secretary of the aluminium industry of the United States drew a very optimistic picture of its prospects, pointing out that a lessening of defence needs would not mean "immediate, sharp curtailment" of stock-pile buying, which could be tailed off over a period, and that, in any case, increased civilian demand would compensate for reduced defence requirements. There were, he stated, in addition to the growing major markets in transport, architecture, electrical installations and packaging, many expanding minor uses of the metal which, taken together, would account for many million pounds of aluminium annually. In the United Kingdom, Tube Investments, Limited, have affirmed their faith in the future of aluminium by going ahead with their plans for the new rolling mill in South Wales, at a time when they have been faced with rising costs of production, and lower sales and selling prices.

Copper may lose some ground in competition with aluminium, but, looking two or three years ahead, the outlook also seems sound enough. Production has expanded rapidly, and smelter output is now nearly one-quarter higher than the 2·8 million tons achieved in 1939. The growth of copper consumption in the electrical engineering, vehicle and building industries, however, has kept pace with the growing output. Moreover, the United States, once an exporter of copper, is now the largest world importer. Since there is no hope of increased output from the mines in the United States, and further increases in consumption are to be expected, imports will have to be considerably increased over the next 25 years. The Paley Commission have calculated that they will double, reaching 1 million tons by 1975. The trend of consumption of three of the major non-ferrous metals in the United Kingdom is shown in Fig. 5.

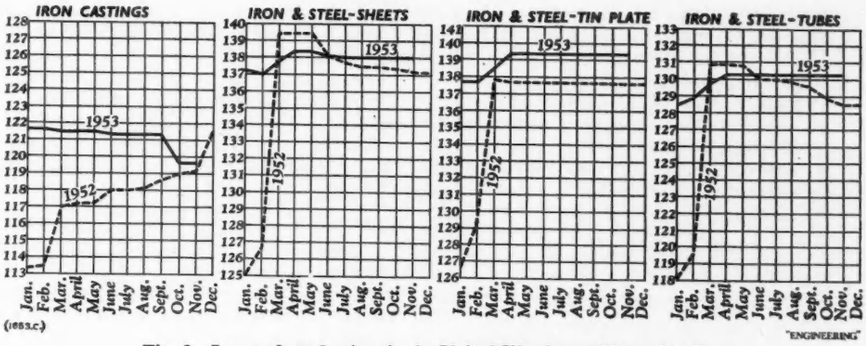


Fig. 3 Iron and steel prices in the United Kingdom, 1952 and 1953. Prices were generally stable in 1953.

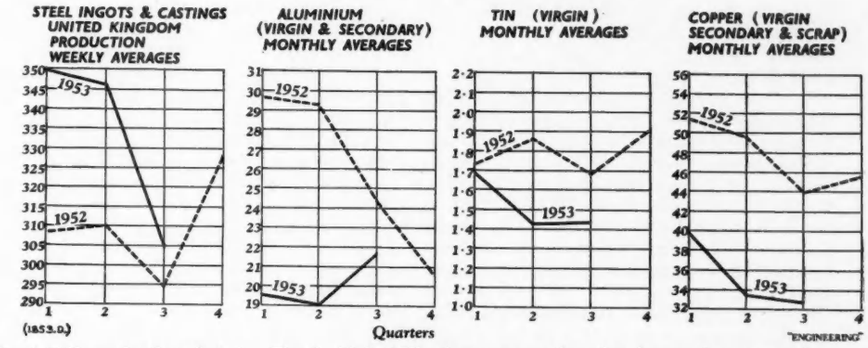


Fig. 4 U.K. production of steel ingots and castings, weekly averages (1,000 tons).

Fig. 5 United Kingdom consumption of major non-ferrous metals (1,000 tons).

LOW PRICE OF IRON AND STEEL IN BRITAIN

The prices paid by users in the United Kingdom for iron and steel, the main raw materials of the engineering industry, have been very stable, as Fig. 3 shows. In November, 1953, prices were generally about the same as, or a little lower than, in May, and, apart from castings and tinplate, they were no higher in May, 1953, than in May, 1952. Despite reductions, export prices are still higher than those charged on the home market, and, although there has been a slump in Continental prices, the British engineering industry still obtains iron and steel more cheaply than any of its competitors. With the exception of plate, supplies of iron and steel in the United Kingdom are now plentiful. Although, therefore, the home market is still taking up as much as the iron and steel industry cares to give it, exports are likely to become a matter of increasing concern, particularly in view of the industry's schemes for extending capacity.

After the record output of 16·42 million tons in 1952, the output in 1953 has again been a record (see Fig. 4). In the period January to October, 1953, it was 9 per cent. higher than in the corresponding period of 1952, so that it is probable that the target of 17·5 million tons set for the full year's production will have been substantially exceeded. The objectives of the original iron and steel development plan, to increase output to 18 million tons by the "middle 'fifties," has thus been well-nigh achieved. The second development plan, announced in March, 1953, will cost £250 millions, compared with £310 millions, and will carry the capacity of the industry to about 20·5 million tons per annum by 1957. Making allowance for estimated imports of 500,000 tons, this will bring the total available to 21 million tons, of which it is expected the home market will consume 18 million tons, leaving 3 million tons for export.

The expansion programmes have been criticised as being inadequate in one respect only, namely, the provision made for expanding the output of steel plate, which at present is limited to additions of 100,000 tons per annum to the capacity of an existing plate mill on the North-East Coast. The supply of plate improved substantially in 1953, but it is still not fully adequate for the requirements of shipbuilders, locomotive builders and boiler makers. Thus there seems to be every justification for the protest put forward by the Iron and Steel Consumers' Council in July, when they declared that "not only is the present position in regard to the supply of plates unsatisfactory, but adequate steps are not being taken to ensure that, in future years, supplies will meet the increasing demand," which, in their opinion, must continue to grow because of increased consumption in the oil, gas and chemical industries. Changing shipbuilding techniques have also increased demand; welded ships, for example, require thicker plates, flanged plates are used extensively, and the use of corrugated plates for bulkheads is growing. Plate consumption by the rolling-stock industries has also been increasing rapidly; the large number of all-steel mineral wagons being built for British railways, for example, has increased the pressure on available supplies.

Taking everything into account, the Iron and

Steel Consumers' Council estimate that the shortage of capacity is somewhere between 250,000 and 350,000 tons a year. This may be an overestimate ; but there seems to be sound evidence to support the claim that too much priority has been given in the development programmes to the expansion of sheet, at the expense of plate. The case will be greatly reinforced if, as is well within the bounds of possibility, home sales of motor vehicles fall off sharply and a surplus of sheet steel results. The outcome of an examination of the programme for extending plate capacity is still awaited.

ESTIMATING FUTURE DEMAND FOR STEEL

The main criticism of the iron and steel development plans is that the projected extensions to capacity are too large. It is thought that some of the assumptions made in estimating demand may not be justified. One of these is that an export market can be found for 3 million tons of steel. But the Continental output of steel has also expanded greatly, and competition is likely to be keen in world markets. Another is that a further expansion in British exports of engineering products can be achieved. This is admittedly necessary if the problem of the United Kingdom's balance of payments is to be solved satisfactorily, but recent trends are not exactly optimistic.

Professor Austin Robinson, of Cambridge, has recently given his opinion that British exports in the next few years may not exceed 154 per cent. of the 1938 volume, or 14 per cent. less than in 1951. This may be an unduly gloomy view, but, as was argued in the first part of this article, the task of the engineering industry in increasing exports in the buyers' market is fraught with great difficulties. A third assumption of the planners, namely, that a high level of capital investment will be maintained in the United Kingdom, can only be justified if, in fact, the United Kingdom succeeds in expanding exports, and, even then, only if sufficient incentive is provided to manufacturing industry to increase its outlay on plant and machinery. The iron and steel industry, of course, does not take full responsibility for the estimates of future demand; these were made in consultation with the Government, who have been responsible for assessing the broad economic trends upon which the estimates are primarily founded.

The consequences of providing an excess of steelmaking capacity could be quite serious, quite apart from the wastage of resources which could be well employed elsewhere. The development plans do not mean simply more coke ovens, blast furnaces, melting shops, etc.; considerable outlay is required from other branches of industry to provide raw materials, fuel and power for the new capacity, so that the cost to the community of 3 million tons of extra steel is much higher than the £250 millions which will be invested by the steel industry. As is pointed out in the *Statistical Bulletin* of the Iron and Steel Federation for September, surplus capacity would mean a substantial increase in the price of steel. It is estimated that, if the industry operated at 95 per cent. of capacity, the capital charges might amount to about £10 per ton ; at 80 per cent. capacity, they would be £2 per ton higher. An increase in the price of steel of this order might well result in a further reduction in demand, and a still wider gap between capacity and output.

The planning programme is not, of course, absolutely inflexible. It is obviously necessary to put work in hand several years before any increase in capacity is required, and, during the period of construction, no radical changes in the general direction of the plan are possible. There is no need, however, to hold rigidly to the objective of 20·5 million tons. For one thing, as new plant becomes available, some of the older and less economic equipment can be scrapped. Some of the new plant which is scheduled to be installed is, in fact, intended as replacement, and if, by any chance, the demand should exceed 21 million tons, it would be possible to meet it by retaining the older plant in service.

Before any final judgment is made on the over-ambitiousness of the iron and steel development programme, two important considerations have to be borne in mind. Firstly, the consumption of iron and steel grew more rapidly in the inter-war years than many "sound" economists foresaw, and, but for the vision of the enterprising iron and steel industry, the capacity at the outbreak of war might have fallen far short of requirements. Secondly, however undesirable it may be to plan for too much steel, it would be fatal to plan for too little. If an increase in exports of metal goods is not achieved, the United Kingdom will be faced with insolvency; the iron and steel industry must therefore accept that it will be achieved, and plan accordingly.

STEEL ABROAD

The reductions in the United Kingdom export prices for steel, announced at the end of November, are evidence of the increased interest which the industry is showing in exports. They also show that there is no longer such a shortage of steel abroad that buyers are prepared to pay almost any price for it. British export prices are still thought to be somewhat above those of their competitors, although, in view of the present Continental practice of quoting below the published list prices, it is not easy to discover the Continental prices for comparable grades of steel. A comparison is also difficult because of the quality premium which can normally be commanded by British open-hearth steel. British export prices, however, are certainly not less than those prevailing on the Continent and, in view of the fact that they are still substantially higher than those charged on the home market, it is clear that no all-out assault is as yet being made to capture export markets. When eventually it is made, stiff opposition must be expected from producers within the European Coal and Steel Community.

The Economic Commission for Europe, in May, 1953, expressed concern that the Western European iron and steel industry might not be able to find export markets for the quantities of steel for which it had budgeted in forming development plans, and that the danger of surplus capacity was very real. In competition with the Continental producers, who have now been organised under the High Authority in the Community which arose out of the Schuman plan since May, 1953, the British iron and steel industry might be in a relatively weak position. It was far from the intentions of the founders of the Coal and Steel Community that it should encourage cartels, but it does not seem that the elaborate provisions for ensuring fair competition among the steel producers have worked very happily in recent months. An export price cartel has existed since the inception of the scheme, although the High Authority has now decided to take action to break it.

Even within the bounds of the common market, it soon became clear that there was some sort of understanding on price policy within the steel industry. It is one of the rules of the Community that steel producers shall publish price lists of their products, and that, although they are at liberty to publish revised lists at any time, they cannot discriminate between consumers by quoting non-list prices. It was expressly forbidden that prices should be fixed by agreement among producers, who were expected so to fix their prices that there would be no fear of their competitors underselling them in their own local market. To guard against the danger that any producer should establish a monopoly in his own area, it was provided that, in certain circumstances, a producer in another area could depart from his own list prices in order to match particular offers made by the local producer. The steel producers seem to have made little attempt to operate in the spirit of the scheme. It has now been admitted that the prices in the published price lists were fixed by arrangement among the producers; they have not been changed since they were first published, and the careful provisions for promoting inter-regional competition have been disregarded.

This flouting of the Community rules, however, has not benefited the steel producers. Shrinking order books made price reductions inevitable, and all have been openly quoting prices which are often very considerably lower, but on the average something like 10 per cent. lower, than their list prices. The High Authority have been taking steps to try to bring list prices into some correspondence with what is actually being charged, but are meeting with such resistance that there is clearly little desire among the producers to work in the spirit of the Community marketing scheme. International disapproval of the policy of the Export Price Cartel has long been increasing, and the High Authority have now given instructions that it is to be discontinued.

The legality of their action is being challenged, however, by the members of the cartel, and disagreement among ring and non-ring members within the Community has heightened the crisis. While the Belgian and Luxembourg steel producers, who have a substantial export trade upon which they rely to cover a large proportion of their overhead costs, are in favour of the ring, the Germans, who sell mainly within the common market, oppose it since the ring members are thus enabled to undercut them in the common market. Dissension of this sort within the iron and steel Community is hardly to be welcomed by the British iron and steel producers, to whom competition, regulated equitably by the rules of the Community, must obviously be preferable to the operation of cartels or a wholly unregulated scramble for markets.

CONCLUSION

Supplies of metals and other materials should present few problems to the engineering industry in 1954. The industries which supply those materials now share with engineering the common problem of marketing in a buyer's market. There is no shortage of labour, and executives on the production side of industry can now have little excuse for not giving the fullest support to their sales departments. This means not merely close attention to such administrative matters as keeping delivery promises and making adequate provision against the despatch of faulty goods, but also a continuous effort to improve designs and to bring down production costs. The problem of increasing productivity is one of the most important of the day and will be discussed in the subsequent article dealing with labour and related subjects.

The first part of this general review of the engineering outlook appeared on page 10 of the January 1 issue. Succeeding articles will examine the prospects of the principal branches of the engineering industry.

SINTERING OF IRON ORE

Concluded from page 18

We conclude below our report of the Symposium on Sinter, held after the autumn general meeting of the Iron and Steel Institute, and deal first with the proceedings at the morning session of Thursday, November 26.

PRODUCTION AND PROPERTIES OF SINTER

The seven papers considered all dealt with some phase of the preparation and production of sinter or of its properties and were taken together for discussion.

The first paper, "Factors Controlling the Rate of Sinter Production," was by Mr. E. W. Voice, Mr. S. H. Brooks, Dr. W. Davies and Mr. B. L. Robertson. It described full-scale trials on the four-strand Dwight-Lloyd sinter plant completed at the Appleby-Frodingham Works in 1951. The authors stated that the plant had been instrumented and careful assessments made of its operation under normal conditions and with modifications such as altered bed height and strand speed. The test data had shown that the sinter make was mainly controlled by the current of air drawn through the bed. Any methods of increasing the air flow would thus enable the output of sinter to be increased. This had focused attention on the permeability of the sinter bed, and the factors affecting permeability; and its fundamental relationships with other variables of the process had been explored quantitatively. Measurements had been made of the bed permeability, while the strand was operating, and methods were found of increasing it. Theories had been developed to correlate the effects of bed permeability, bed height, length and width of the machine, air leakage, fan horse-power, and sinter output. By implementing these results the plant practice had been changed and the sinter output considerably increased. The quality of the sinter, as assessed by the behaviour of the blast furnaces, was maintained. By increasing the sinter make, furnace burdens containing a greater percentage of sinter had been made possible and this had enabled the make of iron to be increased with a reduced coke rate.

The second paper on "The Permeability of Sinter Beds" was by Mr. E. W. Voice, Mr. S. H. Brooks and Dr. P. K. Gledhill. The authors stated that sintering could not proceed without adequate air passing through the bed. Highly permeable sinter beds needed less fan horse-power for a given air flow. Alternatively, for a given fan power, increasing the bed permeability gave greater air flow, and, therefore, greater sinter production. Knowledge of the permeability enabled modifications to the plant or process to be assessed; maximum advantage could then be taken of water additions, size grading, conditions of laying the bed, etc., to increase sinter production, or produce colder sinter. The sinter output had been greatly increased by these means at one plant without any deleterious change in sinter quality.

The third paper was entitled "Permeability Tests on Blast-Furnace Raw Materials," and was by Mr. E. W. Nixon and Mr. F. R. Maw, of the Appleby-Frodingham Steel Company. They stated that a mild-steel cylindrical test apparatus, 7 ft. high and 3 ft. in internal diameter, connected by a 6-in. diameter pipe to the cold-blast main of one of their firm's large blast furnaces, had been employed to study the permeability of blast-furnace burden materials. Although no investigation of fundamental flow data had yet been completed, the series of tests carried out so far indicated that the apparatus had distinct possibilities for solving empirical burdening problems. The apparatus could distinguish easily between high- and low-permeability cokes, but it was not suitable for distinguishing cokes very similar in size distribution; a simple screen analysis might be just as useful. In a series of tests on synthetic sinter mixtures a striking feature was the very large increase in pressure drop caused by using all under ¼ in. sinter in the mixture. In practice, as it would be impossible to use only one size of sinter, the best plan was to reduce or eliminate the smaller-size grades.

"Effect of Mineral Additions and Moisture Control on the Sintering of Sierra Leone Concentrates" was the title of the fourth paper. It was by Dr. P. K. Gledhill, Mr. G. C. Carter and Mr. C. F. Ely, and was submitted by the Sintering Sub-Committee of the Iron-Making Division of B.I.S.R.A. The authors stated that the additions of lime and lime-bearing materials to Sierra Leone concentrates resulted in a decrease in sintering times and a reduction in air requirements. With 4 per cent. of lime, the air-utilisation efficiency was almost doubled. With concentrates of abnormally small particle size, the permeability was apparently greater at 6½ to 7 per cent. moisture, and the sintering times were lowest at 5 per cent. moisture. Additions of blast-furnace slag considerably reduced the sintering times at all moisture contents.

The fifth paper dealt with "Sinter-Plant Assessment Trials at Dagenham and Cleveland." It was submitted by the B.I.S.R.A. Sintering Sub-Committee and was by Mr. R. F. Jennings, Mr. E. W. Voice, Dr. P. K. Gledhill, Mr. G. C. Carter and Mr. C. F. Ely. They stated that both plants, namely, that of the Ford Motor Company, Limited, at Dagenham, and that of Dorman, Long and Company, Limited, at Cleveland, used a variety of foreign ores. In both cases the process variables were generally maintained very close to optimum levels, so that the rates of sinter output and strand utilisation of the Dwight-Lloyd machines employed were consistently high. The sintering air requirements mainly determined the outputs and varied from 42,000 to 89,000 cub. ft. S.T.P. per ton of raw mix, according to the constituents of the mix. The sinter cooling problems at each plant were widely different. Calculations of cooling-zone permeability and cooling-air requirements had been made to match suggested solutions, using forced-air convection, by the addition of three extra wind boxes at Dagenham and the use of a louvred cooling wharf at Cleveland.

The sixth paper, "Towards Faster Sintering of Ironstone," by Mr. M. A. K. Grice and Dr. W. Davies, was in some respects a sequel to the first paper presented. The authors said that these large-scale trials on the Dwight-Lloyd sinter plant at the Appleby-Frodingham Works had indicated that the output was closely related to the average air flow through the strand. Subsequent studies at the Swinden Laboratories of the United Steel Companies, Limited, Rotherham, using a small-scale sinter unit, had indicated that a substantial increase in air flow and hence in output could be achieved by partial pelletising of the feed in a drum mixer. Furthermore, these studies had shown that the benefit of such treatment was much increased if the coke addition were delayed until a later stage in the mixing process. The effect on output of such high-permeability batches had been confirmed in practice by full-scale trials on a Greenawalt plant at Appleby-Frodingham.

The seventh and last of the series of papers, namely, "The Rating of Sinter Plants for Economic Output," by Mr. R. F. Jennings, was another contribution put forward by the Sintering Sub-Committee. Mr. Jennings stated that, so far, the economic rating of sinter plants using a variety of raw materials had been considered in relation to the conditions of system resistance obtainable with the present methods of strand layering. Very substantial advantages were to be obtained from reducing sintering costs and increasing rates of output by improving sinter-bed permeability beyond that already obtainable. New methods of strand layering, devised to give initially a more permeable sinter bed, combined with the drying out of the layered raw mix before ignition, so as to increase the average permeability during sintering, had yet to be applied to plant design. It was expected that the adoption of such ideas with raw materials that readily pelletised would enable the economic rating of plants to be substantially raised in future designs, with corresponding reductions in plant cost per ton of sinter.

DISCUSSION

Dr. T. P. Colclough, C.B.E., who acted as *rapporteur* on the seven papers, said that the fundamental part which the preparation of the ore burden and the sintering of ore fines was playing, and would play, in the economy of pig-iron manufacture needed no emphasis at the present time. To-day the installed sintering capacity in this country was estimated at 5·25 million tons, and it was anticipated that the production for the current year would be about 4·2 million tons. Approximately 3·75 million tons of capacity was under construction or discussion, and it was estimated that by 1956, the production of sinter would be about 8 million tons per annum. This meant that about 4 million tons, or 26 per cent., of the total iron charged into the blast-furnaces, would be in the form of sinter. This was probably one of the most striking changes in blast-furnace practice within living memory.

While the change in the character of much of the ore supplies had made some part of the development imperative, it would be recognised that a heavy responsibility lay upon the technical men to demonstrate that this expenditure was justifiable, to prove that the claims made for ore preparation and sintering were reasonable and could be attained, to establish that the plant employed was of suitable design and construction and to ensure that the operations were sound and economic.

The investigations described in the papers before the meeting had brought out clearly the fact that, although many plants had been installed and much money spent in the last ten years, the designing and constructing engineers had not produced a machine which could be regarded as satisfactory for the purpose. Among the matters dealt with in the papers were irregularity of operation, leakage of air, lack of control points, unnecessary obstruction to gas flow, defective dust-catching systems, excessive use of electric power and inefficient sinter cooling systems: all leading to loss of production, increased operating costs and capital charges. It was a striking commentary that it should be left to the consumers' technical staffs to indicate to the manufacturers the supreme importance of uniformity of feed, moisture additions, avoidable leakages, and wasteful obstruction. From time to time during the past ten years the attention of the designing and engineering contractors had been directed to these problems, and it was to be

hoped that, although much progress had already been made, one result of these investigations would be to stimulate marked and early improvements in both construction and design.

A subsequent speaker, Mr. J. M. Stapleton, said that the present papers had gone far beyond anything that had so far been done in America. Recently, at Gary, Indiana, after a good deal of hesitation, one furnace had been put on a 100-per cent. sinter burden. After a great deal of discussion on how fast the amount of sinter in the burden should be increased, a decision had been made that it should go up very gradually, from the usual 10 or 20 per cent., to 50, 60, 70 and 80 per cent., and above. Finally, it had been decided to work on 100 per cent. sinter, and this was done in a period of ten or twelve days. The furnace ran quite successfully and in the first month of operation the coke rate was 1,325 lb. per net ton of iron. This performance had so surprised the operators in their own company and in the United States that a steady stream of visitors had come to see the plant.

Mr. T. Dennison said that, in his introduction, Dr. Colclough had referred to the growth of sintering capacity in this country and to the considerable developments that might be expected within the next five years. British pig-iron production was planned to increase from 10·7 million tons in 1952 to about 15 million tons in 1957-8. This would entail an increase in the consumption of imported ore of about 60 per cent. and of over 20 per cent. in the consumption of home ore; so that, even assuming that the present proportion of sinter in the burden were not increased, there was clearly scope for a considerable increase in sintering capacity, particularly for imported ore. Compared with iron-making, sintering was a comparatively recent development, and the 1952 average of about 18 per cent. of sinter in the burden was well below the 25 per cent. to 35 per cent. which had hitherto been regarded as the economic limit. Moreover, the amount of fines in home and imported ores was increasing, and greater use might have to be made of imported fines and concentrates.

A comparison of the conclusions reached by the various authors showed that the position concerning the air required to sinter raw material was quite a confused one. In the first paper it had been shown that the specific air consumption at Appleby-Frodingham was remarkably constant, at about 44,000 cub. ft. per ton of raw mix. On the other hand, in the second paper it had been stated " that for a given mixture less air was needed to sinter a ton of raw material when the bed was more permeable." Figures which were quoted for Cleveland in another paper showed that the air requirements there varied from 52,000 to 81,000 cub. ft., and it was claimed that the results indicated that the air requirements per ton of raw mix decreased as the proportion of return fines was increased. Moreover, pilot-plant tests reported on by Dr. Gledhill, Mr. Carter and Mr. Ely showed that the addition of lime-bearing minerals to a mix of Sierra Leone concentrates substantially reduced the amount of air required, to complete sintering. Furthermore, at Dagenham, the air requirements on various mixtures of imported concentrates and fines varied between 45,000 and 90,000 cub. ft. per ton. For a similar mix of Sierra Leone concentrates the laboratory results showed an air requirement of about 73,000 cub. ft. per ton as compared with about 90,000 cub. ft. per ton in the plant trials. The addition of 2 per cent. of lime reduced the air requirements in the laboratory pilot-plant tests to 53,000 cub. ft. per ton, whereas in the plant trials the reduction was only from 90,000 to 81,000 cub. ft. per ton.

Mr. P. Boel said that one of the reasons for the variation in the behaviour of the sintering of various raw materials, concentrates, ore or dry dust depended not only on the total percentage of moisture present, but on the manner in which the moisture was present—whether it was completely coating the raw materials or was just present among them.

Dr. H. B. Wendeborn said that according to the figures given, there was, in England, a sintering capacity of about 5 million tons a year, and in a few years time that capacity would have risen to 8 million tons. In Germany, there was a capacity of 16 million tons a year, and in the past two years there had been an average of 50 to 60 per cent. sinter in the blast-furnace burdens, depending on the conditions.

Major W. R. Brown, D.S.O., said that there had been one or two remarks concerning the shortcomings on the engineering side of the sinter machine. A great deal of credit, however, was due to plant manufacturers for the fact that they had had the enterprise to collaborate with friends in Germany and in America so that when at last the iron-producing industry in this country awakened to the fact that there might be something in sintering, there were plants ready to be erected. A very large part of the brains of B.I.S.R.A. had been " let loose on sinter plants," and they had discovered some air leaks. These leaks had probably been there for 20 years, and had been discovered in the last few months.

Speaking again, Dr. T. P. Colclough said that a very great deal of work was needed on the design of the sinter pan or the sinter strand; if operators were to get the optimum operation in sintering, it was in the strand or pan that there was a greater opportunity for improvement than anywhere else in a sinter plant.

Mr. G. Hustand, speaking as a sinter-plant designer, said that he was not very satisfied with the design of the actual sinter strand itself. He believed that it could be vastly improved, but it was a question of increased cost and they were told that the outlay on the plant was phenomenal, in any case. Quite a number of added advantages could be given, but the initial capital cost would probably outweigh those advantages. Again, there were three kinds of mixers. One was comparatively cheap, another was not so cheap, and a third was expensive, but the qualities of the third mixer were demanded for the price of the first. Moreover, after considering the information given him, the designer would ask whether the materials would readily absorb surface moisture, and the reply would be so dubious that he would probably suggest two-stage mixing, thus augmenting the capital cost. Eventually, one-stage mixing would be accepted for economic reasons. Furthermore, a conveyor design which would deal with sticky Northamptonshire ore could easily be produced, but, again, it would add materially to the cost. He personally had had an opportunity of putting into effect quite a number of the recommendations mentioned in the papers before the meeting, particularly those in the paper on " Factors Controlling the Rate of Sinter Production," and he knew that it had been found that there was much scope for ingenuity, but the question of finance remained the important factor.

Sir Charles Goodeve, F.R.S., said that he was glad to learn that it was the intention of the Iron and Steel Institute to publish the papers and the discussions as a special report. He wondered, however, what was going to happen now that all this information was forthcoming. Would operators apply it to existing plants and would the designers of equipment, in collaboration with the purchasers, be able to take full advantage of it ?

The obvious conclusion to remarks on plant design was that the closer all concerned worked together, the sooner would the best possible equipment be forthcoming. All makers of sinter plant in this country were now members of B.I.S.R.A., and had been coming increasingly into collaboration on this work. As all the companies which were members of B.I.S.R.A. knew, they could make full use of the Association's research equipment, as and when they required, and already some of them were using it.

Mr. F. Pearson stated that there was still much to be done on sinter quality and the size of sinter, and it had been said that there should not be any fines in it. Some 52 per cent. of the sinter that went into the Ford Company's furnace at Dagenham every day was less than ½ in. across, and over 600 tons of sinter was being charged ; every day that sinter was made from nearly 100 per cent. concentrates. The next speaker, Mr. A. Stirling, said that not very much had been said concerning sinter testing. The feeling in the matter, at Stewarts and Lloyds' Corby Works, was that perhaps the old British Standard shatter test for coke might be as good as any, and that was the one now used.

In his reply, Mr. M. A. K. Grice said that the stickiness of the feed in the Appleby-Frodingham plant had been mentioned. They attributed their ability to overcome this stickiness of the ores used to dusting them with coke after they had been pelletised. This made an extremely free-running mixture, and there was no sign of stickiness. Mr. E. W. Voice, in his reply, stated that the actual term " air requirement " had grown up rather because they were trying to decide on the design of new plant to meet a guaranteed tonnage of sinter manufacture, and necessarily, therefore, they were thinking in terms of the air required for that plant. What was really meant was the air required under known sintering conditions.

The last session of the symposium was held in the afternoon of Thursday, November 26.

SINTER BURDENS AND SINTERING PRACTICE

The two papers on the agenda were discussed jointly after presentation. The first, " Iron-making from High-Sinter Burdens," was by Mr. G. D. Elliot, Mr. J. A. Bond and Mr. T. E. Mitchell, of the Appleby-Frodingham Steel Company. In their absence it was presented by Mr. H. S. Ayres. The authors stated that they had noted some of the important effects of changing from a burden based wholly on home ores and containing about 35 per cent. of sinter to one consisting of 95 per cent., or more, of sinter. It was certain that the future would witness an increasing use of wholly-sinter burdens. The practice had much to commend it, for both lean- and rich-ore working. For many years, the greater part of the pig-iron tonnage produced in Sweden had been produced from wholly-sintered burdens – the fluxing lime being introduced via the sinter – and for many years the coke consumption at many Swedish furnaces had been enviably low. Appleby-Frodingham experience had confirmed that Swedish experience applied equally to large (25-ft.) furnaces utilising low-grade burdens. Logically, the use of 100 per cent. sinter burdens must be correct. It extended the trend of many years in relieving the furnace of as many duties as possible, so giving it more time to do its primary task of reducing iron oxide to iron.

The second paper, entitled " Sintering Practice at Domnarfvet, Sweden," was by Mr. C. Danielsson, who stated that the sinter plant which now produced about 700,000 tons of sinter per annum, was of normal Greenawalt design and had been

built in 1934. It had been extended several times and now had six pans, each 26 ft. by 10 ft. The depth of the bed was 1 ft. The time between two subsequent charges was 31 to 32 minutes, of which about 2 minutes were used for charging and 4 minutes for ignition. In 1943 the production of fully self-fluxing sinter had been started up; since then, no limestone and hardly any other additional constituents of the burden had been charged directly into the blast furnaces.

DISCUSSION

Dr. T. P. Colclough, C.B.E., who opened the discussion, said that the experience at Domnarfvet proved the validity of the suggestions made from time to time that the certain method to improve blast-furnace practice as regards production, coke rate and efficiency lay in the preparation of the ore and the sintering of the fines. It was also clear that this high efficiency was a direct reflection of the uniformity of distribution and gas flow which was demonstrated by the small variation in CO_2 across the stock column. Incidentally, the performance of this small furnace of 14 ft. 9 in. hearth diameter and 7,800 cub. ft. working volume producing 5·5 tons of iron a day per 100 cub. ft. volume must raise some doubts as to the soundness of the Productivity Team's recommendation that no furnace should be installed of less than 25 ft. hearth diameter.

At Appleby, the increase in sinter in the burden from 35 per cent. to 95 per cent. had given an increase in production of 30 per cent. and a decrease of coke rate of 22·4 per cent., and there was little doubt that this performance would be improved still further as and when greater blowing power was available.

The next speaker, Mr. E. M. Summers, said that as a foundry-iron producer he had to bear in mind the question of iron quality. The question that he would like to ask was whether it was reasonable to expect that this 100 per cent. sinter practice was applicable to the production of foundry iron.

Mr. J. Walsh, who followed, said that since August, there had been in operation at the Gary Works of the United States Steel Company, a 25-ft. hearth furnace working on 100 per cent. sinter. On going to 100 per cent. sinter, the coke rate had been reduced from approximately 1,700 lb. to 1,325 lb. of coke per net ton of iron. An analogous increase in production in the neighbourhood of 20 per cent. had also been attained.

Mr. W. Hunter said that he would not like it to be thought that 100 per cent. sinter was the answer to all blast-furnace problems, because it was not. There was a need for a test which would give some measurement of sinter quality. The suggestion of a shatter test, made that morning, was a very good one. Finally, coke quality was of great importance. The Dagenham furnace, for example, was running extremely well, but that could not be ascribed only to the sinter; a large part of the credit had to be given to the good coke employed. The next speaker, Mr. F. Pearson, stated that the sinter should be in such a condition that a piece of it about 6-in. diameter could be pulled to pieces in the hand. Furthermore, the FeO content was the deciding factor, and this should not be below 12 per cent.

Mr. F. W. Nixon said that there were, at Appleby Frodingham, extensive data on size analysis, shatter tests, drum tests, magnetic-separation and other tests over the past few years; but, as yet, it could not be stated definitely that the real answer regarding what denoted optimum sinter quality for blast-furnace operation had been found. It would be a very great step forward if a simple index, physical or chemical, could yield that information in a simple and elementary test.

Mr. A. T. Ledgard said that the authors of each paper had had a blast-furnace problem to solve. Though the final result was identical, namely, 100 per cent. sinter burden, the problems dealt with were most diverse. Mr. Elliot and his colleagues had been working a burden which was very reducible and prone to excessive carbon deposition, with the resulting erratic working and the furnaces were very prone to scaffolding. Mr. Danielsson, on the other hand, had ores that had been proved to be practically irreducible in the furnace stack with carbon deposition non-existent. Mr. Elliot and his co-workers now intended to crush all their material to ¼ in. in size and manufacture a self-fluxing sinter, this sinter being fairly hard to reduce, while Mr. Danielsson now took all the fines from his Swedish ores, exported all the irreducible lumps, and sintered the fines also to a self-fluxing product. The resulting practice was revolutionary. Our Swedish friends thought so little of the stack for reduction and initial preparation that it was merely 22 ft. high, and the three English authors speculated on the reduction of stack height for 100 per cent. sinter burdens. Dr. Colclough might yet see low stacks in this country.

Mr. H. S. Ayres, who replied on behalf of Mr. Elliot, Mr. Bond and Mr. Mitchell, said that one or two speakers had commented on the economy of the process. It was cheaper to make iron using 100 per cent. sinter in the burden. Another factor was that the coke breeze used as fuel in sintering was obtainable at two-fifths of the price of ordinary coke. But the most important benefit secured from using 100 per cent. sinter had been the increased output. It was a fact that, by raising the sinter content in the burden from 35 per cent. to 95 per cent., 150 tons a day had been gained on one furnace. On four furnaces, that was almost equivalent to having another furnace. With regard to blast temperatures, they were now running at full stove capacity without any reserve heat whatsoever, and they were operating at about 750 deg. to 800 deg. C.

Mr. C. Danielsson also briefly replied and the meeting concluded with a vote of thanks to the authors of the papers in the symposium and to others who had contributed to the success of the conference.

SMALL HYDRO-ELECTRIC PLANTS

LOW COSTS OBTAINABLE WITH INDUCTION GENERATORS

The development of small hydro-electric sites with heads of 20 ft. or more is largely a question of economics. For that reason, as pointed out by Mr. H. H. Brown and Mr. A. R. Klann in a paper published in *Electrical Engineering* for December, 1953, stations are being constructed in the United States in which all or part of the conventional building structure is omitted. Although an outdoor gantry crane is often provided to enable the machines to be lowered through a hatch into an inside repair bay, in many cases mobile cranes are being used. The most important factor in such developments is, however, the employment of induction generators and simple automatic controls, a combination which, it has been found, materially reduces not only the capital expenditure, but also the operating and maintenance costs.

THE 2,400-H.P. WAY DAM PLANT

To illustrate these points the authors give descriptions of two actual plants in which induction generators are installed. The first of these is operated by the Wisconsin Michigan Power Company and is known as Way Dam. The dam itself impounds a reservoir, which covers 7,000 acres and gives a maximum head of 38 ft. It is normally filled to capacity about the middle of May, but may be drawn down by 15 ft. before the autumn rains.

The station is constructed of reinforced concrete and glass blocks and is only 12 ft. high. An indoor crane could not therefore be installed, so that an outdoor hoist is employed for transferring the plant through a 13-ft. circular hatch above the generator.

The generating plant consists of a vertical fixed-propeller turbine with an output of 2,400 h.p. at 225 r.p.m. under a net effective head of 35 ft. It is coupled to an induction generator with an output of 1,800 kW at 4,160 volts and 80 per cent. power factor. The rotor is of simple squirrel-cage design, its resistance being less than that of a similar induction motor in order to improve the efficiency. There is no governor, exciter, field rheostat or voltage regulator.

A direct-current motor, supplied from a 48-volt battery, is used to operate the turbine gate, in conjunction with a mechanical head-regulating device. The set is started by closing a master switch, which opens the turbine gate to a pre-set minimum load position and connects the alternator to the 'bus-bars when synchronous speed has been reached. The gate is then adjusted by a time switch, which first causes it to open to a position determined by limit switches and thereafter alters it at predetermined intervals. Manual control is also available and devices are provided to shut the plant down automatically in emergency.

A SIMPLE 155-H.P. STATION

An even smaller development, of which a description is given, is that known as Lower Paint Dam in Upper Michigan. In designing this scheme extreme simplicity was the keynote and the plant was installed inside the dam in order to obtain the maximum output from the 85 cub. ft. per second of water which is continuously passed down the river. The turbine is of the fixed blade propeller type with an output of 155 h.p. at 514 r.p.m. under a net head of 20 ft. and is coupled to a standard 440-volt 60-cycle three-phase induction motor, which operates as a 100-kW generator. The turbine has no gate or governor and the generator equipment is of the same simplicity as that at Way Dam. Operation is fully automatic and if the power fails the turbine runs away at a speed of about 900 r.p.m. This, however, can do no harm on such a simple plant. When power is restored a switching system enables half the line voltage to be connected to the generator, thus reducing the speed nearly to that of synchronism. After a short interval the full voltage is applied to the machine and the speed falls slightly so that the full output is restored.

The authors consider that the results obtained with these two plants should promote a revaluation of sites below 50 ft. heads where outputs between 100 and 2,500 kW are available and where induction generators and automatic equipment can be used.

42-FT. VERTICAL BORING AND TURNING MILL

MACHINING 140-TON WORKPIECES FOR HYDRO-ELECTRIC PLANT

From time to time, the requirements of heavy engineering, and in particular those requirements connected with the development of large electrical generators and hydro-electrical equipment, have called for outsize machine-tools of the vertical-boring and turning-mill type. These machines have generally been either of the type in which the maximum swing and a full diameter work-table are accommodated between two fixed uprights, or of the rather less satisfactory extension-type, in which a much smaller table is used and the maximum work-swing is obtained only by adjustment of the complete column and cross-slide assembly along slide-beds towards the rear of the machine.

The 42-ft. vertical boring and turning mill recently completed by Craven Brothers (Manchester), Limited, to the order of the English Electric Company, Limited, for installation in the new Toronto works of their Canadian associates John Inglis and Company, Limited, is of the fixed double-column type with a 41-ft. table. It is capable of swinging work up to 42 ft. 6 in. in diameter between the uprights, and of accommodating work up to 13 ft. 4 in. in height beneath the tool-boxes. Weighing approximately 650 tons and occupying a floor space of 63 ft. by 58 ft. 6 in., this machine has an overall height of approximately 40 ft., and is capable of handling workpieces up to 140 tons in weight.

The machine embodies independent electric-motor drive to the table, to each ram saddle, to the cross-slide elevating and locking motions, and to the main lubrication systems and speed change mechanism. Interlocked electrical equipment reduces, as far as possible, the risk of damage due to mishap. Other special features include an oscillating planing-motion drive to the work-table and dial indication of the table track and spindle-bearing temperatures.

CONSTRUCTION OF BED AND TABLE

The machine bed is constructed in eight sections: two main sections support the rear half of the table and three further sections support the front half of the table. Additional outer bed wings are arranged to carry the two uprights, and the whole assembly is completed by a small extension piece at the rear. All the sections are accurately keyed to their adjacent sections, and are securely bolted together to form a single rigid unit.

The bed assembly is supported on its foundations by numerous screw-operated levelling wedges, carefully positioned to distribute the total load of the machine and workpiece over a wide area and thus to avoid distortion. All wedges are accessible for adjustment from trenches formed in the foundations, thus facilitating both initial and future levelling operations.

The work-table, 41 ft. in diameter, comprises a central circular portion 14 ft. in diameter, to which twelve separate segmental pieces are accurately jointed and keyed to make up the full table.

The vertical load of the table and workpiece is supported by three concentric flat tracks mounted on top of the bed. The inner track supports the central 14-ft. table member, while the intermediate and outer tracks support the outer table segments. All three tracks are constructed in sections jointed together and fitted with bronze bearing pads. For central location, the table has a 4 ft. 6 in. diameter spindle of conical form which rotates in bronze bearings, which are secured in a sleeve member with vertical adjustment inside a circular housing located and secured in the bed, thus enabling very fine running clearances to be readily obtained and maintained at all times. The sleeve is raised or lowered as required, by means of a pinion key which is passed down through the table to engage and rotate a large-diameter nut mounted on the sleeve. A locking mechanism secures the nut in position after adjustment.

Lubrication of so large a rotating unit – weighing approximately 170 tons and supporting a workpiece of perhaps 140 tons – is of paramount importance. The spindle runs in an oil-bath formed by its bearing housing, in addition to which there is a pressure oil feed direct to the bearing faces. Duplicate sets of oil pumps, driven by two separate 5-h.p. motors, supply the table lubrication system; one set is for general use, the other set being held in reserve to be brought into action by the operator, either in the case of emergency or when dealing with particularly heavy loads. Each set comprises three plunger-type pressure pumps and three low-pressure gear pumps. One pressure pump is used to feed oil through a filter direct to the bearing pads of each separate track. The pump for the inner track also supplies the spindle bearings, and a separate gear pump provides additional flood lubrication to each of the tracks. The flow of spent oil from each track is directed to operate a mercury-type switch before returning to the large supply tank in the foundations, the electrical arrangement being such that the full quantity of oil must be flowing from all three circuits before the main-table drive motor can be started. Should the oil flow diminish or fail, an indication light on the main control desk is extinguished and the machine is automatically stopped.

Ten electrical resistance thermometers, situated at intervals around the three table tracks and spindle bearings, register – either in turn or by individual selection as desired – on a dial in the main control desk. Should the bearing temperature indicated for any point exceed a predetermined maximum, an alarm bell rings and two warning lights on the desk are illuminated.

DUAL DRIVE TO TABLE

The main drive to the table is by two 150-h.p. variable-speed direct-current motors, with a 3-to-1 speed range, operated from a single 410-h.p. Ward Leonard motor generator set. The two motors are electrically connected so that they share the total load equally. Each motor is directly coupled to a separate three-speed gearbox located at the rear of the bed, from which the drive is transmitted through a power-operated multi-plate friction clutch to bevel reduction gears within the bed. The driven shaft from the bevels passes down to further large reduction gears housed beneath the bed, and from them to a second vertical shaft at the top of which is mounted a final driving pinion.

There is, therefore, a perfectly balanced drive through two separate pinions which mesh, at points approximately 90 deg. apart, with a single 26 ft. 5 in. diameter 13-in. face external table gear-ring. The gear-ring is mounted on a disc-type driving plate spigoted to the central table section and secured to the underside of all table sections in the form of an effective sealing member. This driving plate also embodies the intermediate table bearing facing and had important functions in the assembly and machining (by the machine itself) of the outer table segments.

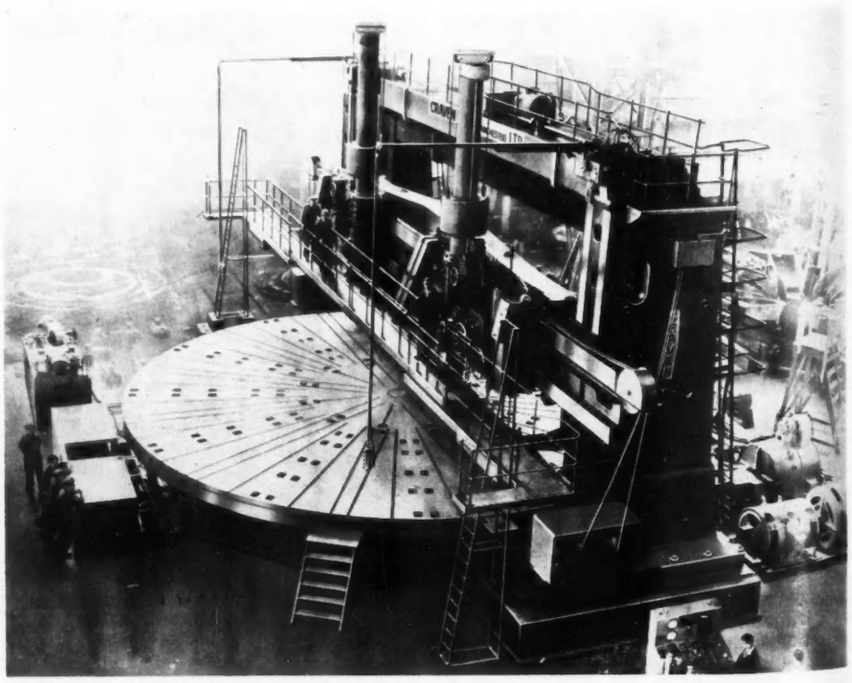


Fig. 1 This boring mill weighs 650 tons. It has been built for export to Canada, where it will be used in the construction of hydro-electric plant.

Motor-driven oil pumps provide cascade lubrication for the two driving pinions at their points of contact with the table gear-ring, while a special oil-tray collects the spent lubricant and forms a pump supply reservoir. Automatic oil circulation is also provided for the reduction gearing in the bed. Special provision has been made for the whole of the table pinion drive to be dismantled and reassembled from below the bed, when the machine is in position on its foundations, without removing the table or its bearing tracks.

In conjunction with the three-speed gearboxes, the variable-speed motors give a stepless table speed range from 0·15 to 3·5 r.p.m. All gear-changing in the two boxes is carried out electrically and is effected by switches on the main control desk. Further push-button switches on the desk control a separate 1½-h.p. motor which engages or disengages the two main-drive friction clutches simultaneously. By this means, the gears may be relieved of all load and "inched" round to facilitate gear changing. Electrical synchronising ensures that the main motors cannot be started for continuous rotation until the two gearboxes are set to the same ratio and also until the clutches have been re-engaged.

AUXILIARY "PLANING" MOTION

In addition to the normal continuous rotation of the table, the electrical equipment is also designed for automatic partial rotation and reversal for the purpose of machining intermittent or local surfaces in the manner of a planing machine. For this operation, planer-type control is provided, and a two-way switch selects either normal rotation or planing motion. In the latter case, trip dogs, adjustably mounted in a T-slot around the edge of the table, control the arc of rotation by action on reversing switches mounted on the bed adjacent to the right-hand upright. The equipment includes a speed retarding control, operating automatically immediately prior to reversal, in order to minimise over-run when machining into restricted tool "lands."

The planer-type cutting stroke is available in the normal table direction only, at rates varying from 0·15 to 1·2 r.p.m., the arc of cutting ranging from a minimum of about 5 ft. measured on the edge of the table to nearly a complete revolution. A Craven planer-type feed control provides intermittent feeds, from 0·006 in. to 1·0 in. per stroke in the horizontal direction, and from 0·003 in. to 0·5 in. per stroke in the vertical direction; these feeds are available on the right-hand saddle only, for use when planing. Two graduated dials on the front of the saddle control the amount of feed applied at the end of each return rotation of the table (Fig. 3).

The two uprights each weigh approximately 27 tons, and form a rigid support for the heavy cross-slide. They are securely connected together across their tops by a deep box-section cast-iron tie beam. The uprights have wide vertical slideways both on their front and inner side facings to locate the cross-slide.

With an overall length of 56 ft., the cross-slide weighs approximately 72 tons and is built in four cast-iron sections bolted and keyed together. These sections comprise the main central horizontal slideway member, 38 ft. long, and weighing 38 tons, two end-sections each weighing 9 tons, with vertical faces to fit the uprights and a rear stiffening member weighing about 16 tons. An electrically-operated mechanism, driven by two 3-h.p. motors, effectively locks the cross-slide to the uprights when in the required working position, as shown in Fig. 2.

The whole cross-slide unit is raised or lowered at a speed of about 12 in. per minute by four 5 in. diameter 1-in. pitch vertical screws, arranged adjacent to the inner faces of the uprights, and passing through long nuts built into the cross-slide. The screws are driven by four worm reduction gears, through shafting, from a 40-h.p. direct-current motor, centrally situated on the tie-beam. Separate adjustment is included for each worm unit to ensure that all screws equally share the load and that the cross-slide is maintained at its correct level. Additional safety nuts are provided which do not normally take any load and are thus free from wear. Special dial-gauge devices indicate the degree of wear which takes place in each main nut and thus facilitate correction when necessary. The electrical control system is such that the cross-slide must be locked to the uprights before the main motors can be started.

INDEPENDENT SADDLE TRAVERSE

Two saddles are mounted on the cross-slide, each having a hexagon ram fitted with a three-position tool-box. Power-operated swivel-slides allow the rams to be set at any angle up to 30 deg. on either side of the vertical position. Each saddle is complete with its own 5-h.p. variable-speed traverse motor and feed gearbox—an arrangement which eliminates the necessity for the usual long feed shafts and screws. The motor provides horizontal traverse of the saddle along the cross-slide, through worm reduction and rack and pinion gear, and vertical traverse to the ram by means of a centrally-positioned screw. The motor is reversible, and is controlled by push-button switches to give continuous rotation for feeding, or "inching" drive for quick traverse. A hand-lever on the gearbox selects the saddle or ram traverse and a further lever operates friction clutches inside the box to engage mechanically for quick traverse or feed.

In the latter case the 3-to-1 range of the motor is augmented by a series of six gear changes to give a total traverse-speed ratio in inches per minute of sufficient extent to provide a nominal feed range in both the horizontal and vertical directions of from 0·013 to 0·75 in. per revolution of the table. Both motor-speed variation and mechanical gear-changes can be made without stopping the machine. The tool rams have a vertical travel of 8 ft. 6 in. in their swivel slides, while the speed of the horizontal quick traverse of the saddle is 8 ft. per minute, and that of the ram 4 ft. per minute vertically. By making use of the "inching" control when the feed clutch is engaged, a very fine power adjustment is obtained at the tool point, thus almost obviating the need for final hand adjustment.

CONSTRUCTION METHODS

The design of the table, with its central circular section and 12 outer segments all tied together by an additional driving plate or sealing member, greatly facilitates pattern-making, casting and machining. The central section, spindle, driving plate and gear ring, all being within normal turning capacity, presented no machining difficulties, while the same conditions applied to the inner and intermediate concentric bearing tracks for mounting on top of the bed. The outer table segments, however, were arranged for planing, with the exception of their inner bore and outside diameter, as also were the sections of the outer bearing track.

These arrangements allowed the driving plate, gear ring and outer-table segments to be assembled on their tracks without the central section and to be rotated at suitable speeds by the machine's own drive, so that the inner bore of the segments could be accurately machined by means of a stationary tool-post set up inside the bore. To facilitate this operation, the intermediate track was provided with a spigot face on which the driving plate could be temporarily located for rotation. This set-up also allowed the centre of the bed to be bored for the spindle-bearing housing, using a beam member and tool slide bolted to the rotating-table segments.

On completion of the above operations, the outer segments, gear ring and driving plate were dismantled, the temporary spigot removed by machining, and the spindle housing, spindle and complete table unit finally assembled. The outer diameter of the table was turned and a final facing operation carried out on the table top by the machine's own tool rams at a much later stage of the construction.

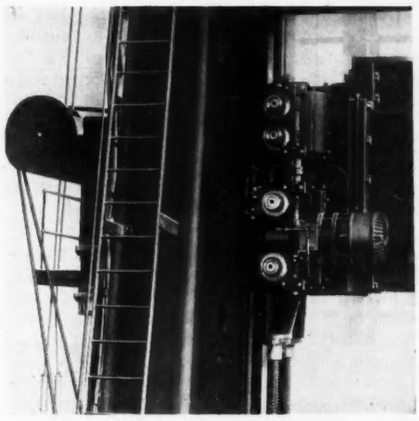


Fig. 2 Mechanism for locking cross-slide. Two 3-h.p. motors drive wormwheels on the nuts of four clamping bolts.

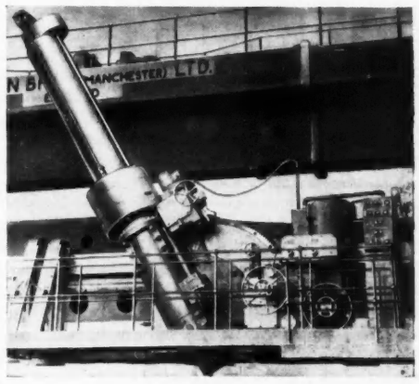


Fig. 3 Right-hand ram saddle swivelled 30 deg., showing the two auxiliary planing-motion feed control dials. The table can be partially rotated in opposite directions repeatedly for "planing" segmental areas.

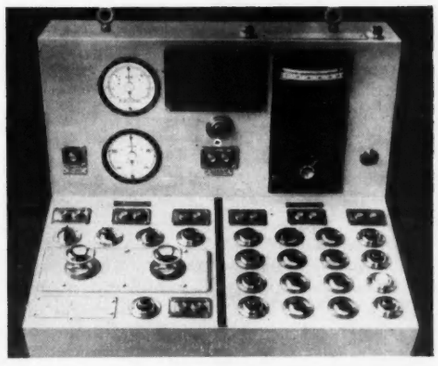


Fig. 4 Main control desk, which includes 13 safety warning lights.

The manufacture of the table driving ring is also of considerable interest. With an outside diameter of approximately 26 ft. 5 in., it was, of necessity, built up from six separate forged-steel segments of the required curvature. After being machined on the top and bottom faces, these segments were bored, drilled and slotted for the jointing faces and tie bolts, and were assembled on a large boring mill table where all turning operations could be carried out. Preliminary tooth gashing operations were then performed on the dismantled segments in a gear-slotting machine, after which the ring was completely re-asembled, this time on the driving plate – itself built up from six cast-iron sections – and mounted in a 27-ft. Craven gear-hobbing machine.

Final tooth-generating operations on the gear ring were carried out by the hobbing process, using a 12 in. diameter inserted-tooth, all-ground hob 12 in. long, of Craven manufacture, and the accuracy of this 330-tooth 3-in. pitch gear was well within the limits laid down by the British Standards Institution.

ELECTRICAL OPERATION AND CONTROL

Twenty-eight motors and generators are employed for operation and control of the mill. The electrical system includes special control circuits and interlocking devices designed to ensure safety and convenience.

The primary supply for the whole machine is 550 volts, 3 phase, 60 cycles, from which the 410-h.p. motor-generator set and all the smaller auxiliary motors operate. Push-button switches and control circuits for the alternating-current auxiliary motors work on 110 volts, 60 cycles supply, while those for the main driving motors, feed motors and elevating motor operate on 220 volts direct-current supply which is obtained from the motor-generator set.

In view of the automatically-reversing planing motion and the power required, the two 150-h.p. variable-speed main driving motors operate on the Ward Leonard principle from the motor-generator set. They have a 3-to-1 speed range and are specially coupled electrically to share the load. Together, they give a total power output of 200 h.p. at 200 r.p.m., and 300 h.p. from 300 to 600 r.p.m. The five-unit motor-generator set comprises a variable-voltage main generator (the voltage being in accordance with the speed of the motors), an auxiliary generator supplying 220 volts direct-current for the feed and elevating motors and for their control, a control exciter for the main generator field and a normal exciter for the main motor fields and control circuits.

The two variable-speed saddle motors, running from 500 to 1,500 r.p.m., have a continuous rating of 5 h.p. for feed, but will, in fact, give 7½ h.p. at 1,500 r.p.m. when used intermittently for quick-traversing purposes. The motor on the right-hand saddle only is also arranged to give suitable feeds for planing, the amount of feed applied at the end of each return stroke of the table being controlled by two graduated setting dials on the front of the saddle.

The motor-generator set is started and stopped by a main circuit-breaker and an automatic rotor control panel. A further panel unit houses the Ward Leonard control equipment and the elevating-motor control, while a fourth unit contains all the alternating-current auxiliary control equipment. An English Electric magnetic amplifier is provided to control the rates of acceleration and reversal.

Operational switches and features embodied in the main desk-type station (shown in Fig. 4), adjacent to the right-hand upright, include a master supply switch and "on" and "off" push-buttons for the magnetic amplifier. It is necessary for the latter to be switched on before starting the machine. Six buttons control the main motors for "start" and "stop," "forward" and "reverse," "inching" and "speed," and "accelerate" or "retard." A further switch selects forward or reverse table rotation or planing motion, and controls are included for the oil pumps, cross-slide elevation, cross-slide locking, feed motor speed regulation and change-over to planer-type feed motion. Gear-changing in the main gearboxes and operation of the main friction clutch are also effected from the main control desk, where 13 coloured safety lights indicate at a glance the position of the more important controls.

Smaller desk-type push-button pedestals on each saddle control the main motor and the saddle motors for turning, boring, planing and quick power traverse. Two further push-button stations of the pendant type, suspended from swivelling arms, duplicate the main motor controls and operate the feed motors for turning, boring and quick traverse only.

The main motors cannot be started for continuous running until both gearboxes are in the same ratio, and the two friction clutches engaged. It is possible, however, to "inch" the motors round for gear changing without these conditions being fulfilled. Conversely, the gears cannot be changed or the clutches disengaged while the main motor is running. Should the main motors stop, then the feed motors will stop also, and it is not possible to start the feed until the main motors are running.

All electric motors and generators were supplied by the English Electric Company, Limited. The electric control equipment was built mainly by Brookhirst Switchgear, Limited, in collaboration with Craven Brothers, Limited, who were responsible for the general design of the whole electrical scheme.

DIESEL-ELECTRIC LOCOMOTIVES FOR WESTERN AUSTRALIA

The increasing use of Diesel-electric locomotives for shunting and train operation on branch lines may be illustrated by referring to a 410-h.p. unit, 18 of which have been ordered from the British Thomson-Houston Company, Limited, Rugby, by the Western Australian Government Railways. One of these locomotives arrived in Australia early in October and six more will be shipped during 1954. They have been specially designed for severe service and, owing to the high ambient temperature and humidity, the 500-h.p. engines have been de-rated to 410 brake horse-power at 1,250 r.p.m. This de-rating will also assist maintenance – an important point, since many of the engines will have to operate in up-country yards and stations, where they will be in use for months on end. The full engine power is available over a wide range of speeds, and good visibility for each direction of running is ensured by placing the cab in an intermediate position. As the power and braking controls are duplicated, driving is facilitated.

MECHANICAL CONSTRUCTION

The locomotives, one of which is shown on the opposite page, run on a 3-ft. 6-in. gauge line. They are 39 ft. 0¼ in. long over the couplers, 8 ft. 3 in. wide, and 12 ft. 5⅜ in. in overall height. They are of the Bo-Bo type with a bogie wheel base of 7 ft., and their approximate weight in full running order is 39 tons. Their tractive effort will be 23,000 lb. at starting and 9,000 lb. continuously, the maximum service road speed being 40 m.p.h.

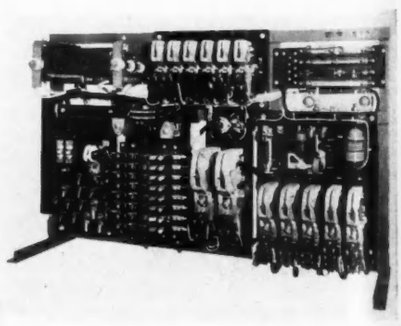
The mechanical parts for these locomotives are being made by the Clayton Equipment Company, Limited, Tutbury, near Derby, where assembly and testing are also taking place. The main frame is of riveted and welded construction and is built up of rolled-steel sections. The floor plates are of aluminium. The four-wheeled bogies consist of side plates with deep reinforced plate cross-bearers, which are secured by riveting. The wheels are solid-rolled, the axles being borne on Hoffmann roller bearings. There are one laminated and two coil springs for each axle-box, and manganese-steel liners are fitted. These springs are attached to the frame by sword-type links and hanger brackets. Cast-steel bogie centre pivots and side bearers, with phosphor-bronze wearing pads, are fitted, and the horn guides have renewable oil-hardened liners.

The cab and casing frameworks are built up of rolled-steel sections clad with aluminium panels. The roof has an inner wooden lining, between which and the outer metal lining is a ventilating space. Access to the cab and to either side of the engine compartment is by a walk-way. The engine-generator set is placed forward of the cab under a bonnet, the sides of which are hinged and have louvred doors. The roof of the compartment is removable, so that the unit can be lifted out as a whole.

ENGINE DESIGN

The engines, which were designed and constructed by Davey, Paxman and Company, Limited, Colchester, are normally aspirated and are illustrated opposite. The 12 cylinders are 7 in. in diameter with a stroke of 7¾ in., the piston speed being 1,615 ft. per minute and the brake mean pressure 73 lb. per square inch. At the 410 brake horse-power rating the dry weight, including the air and oil filters, water pumps and vibration damper, is 19½ lb. per horse-power. The engine is 7 ft. 8 in. long, 4 ft. 2 in. wide at the top and has a maximum height of 5 ft. 2½ in.

The crankshaft, a heat-treated alloy-steel forging, is not hollow-bored in either the journals or pins. The journal diameter is 70 per cent. and the pin diameter 65 per cent. of the cylinder bore, a combination which reduces the inherent torsional vibration. The main bearings are of steel lined with copper-lead, a lead flash being incorporated for quick running in. The exceptionally large amount of material in the crankcase at the crank centre-line gives lateral rigidity



Electric control equipment.

and assists quiet running. This rigidity is supplemented by that of the bearing housings themselves, the underslung caps being let into the crankcase and the side thrust being taken by fitted metal and not by studs in shear. A further tie is provided by lateral bolts which prevent sideways movement or deflection.

The connecting rods are of the fork-and-blade type. The big-end bearings consist of a block which is attached to the forks and rides on a pin running through a steel-backed copper-lined shell. A steel-backed copper-lead bearing is retained in the blade rod over the chromium-plated external surface of the block.

FUEL AND COOLING SYSTEMS

The castings forming the cylinder bank on each side are bolted to the cast-iron crankcase, the angle between them being 60 deg., which is theoretically correct for a 12-cylinder V-engine. Individually-cast Ricardo combustion chamber heads are mounted above the cylinders, each being provided with two valves which are operated by conventional push-rod and rocker gear. This gear is actuated by a single chain-driven camshaft, which is installed in the V-space between the cylinder banks. The pistons are of Y-alloy and carry three pressure and two scraper rings.

The fuel system is pressurised and incorporates a capacity vessel on the engine, which is supplied by a lift pump. Cooling is effected by two panel radiators on the sides of the bonnet, air being drawn in by a fan in the casing roof, which is driven from the engine and exhausts through the roof. Thermostatically-controlled valves automatically by-pass the radiators when the circulating water temperature falls below 140 deg. F. The centrifugal pump for the circulating water is also operated through gearing from the free end of the engine. Forced lubrication is employed throughout, the necessary pressure being generated by a gear-driven pump, which supplies the engine at a pressure of 50 lb. per square inch through triple full-flow filters. A second pump passes oil at low pressure through the oil sections of the radiators.

SPEED CONTROL

The engine is direct-coupled to the main generator, which was manufactured by the British Thomson-Houston Company and has been specially designed for the severe duties associated with Diesel-electric traction. It is a single-bearing machine with a self-aligning roller bearing at the commutator end. The magnet frame is of fabricated steel and carries supports on which the auxiliary generator and overhung exciter are mounted, both these machines being driven by V-belts from the main generator shaft. Class B insulation, consisting of mica, glass and asbestos, treated with a high-temperature insulating varnish, is used throughout. Three windings—a differential series winding, a self-excited winding and a field winding supplied from a sensitive exciter—are used to give the generator an inherent characteristic which limits the maximum voltage on light load and the maximum stalling current on overload. When the demand exceeds the torque permitted by a fuel stop on the engine regulator the speed begins to fall, thus reducing the generator output, this decrease being assisted by the fall in excitation from the speed sensitive exciter. A small reduction in engine speed therefore restores the balanced torque conditions with only a small drop in engine output. Each pair of motors is force-ventilated by a blower, which is belt-driven and draws in air through filters.

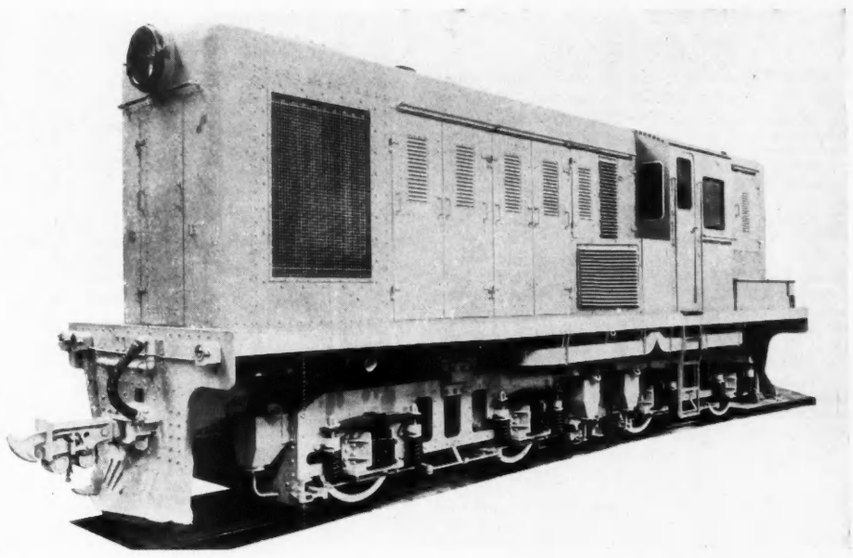
As previously mentioned, the controls in the driver's cab are duplicated, there being a power controller and reverser drum as well as an instrument panel and speedometers at both positions. The power controllers are mechanically linked with the governor lever and enable the engine speed to be adjusted. When placed on their first notch an interlock switch energises the motor contactors. The controllers also adjust the shunts of the motors to provide a weak field for high-speed running, a weak field relay, which operates at a predetermined current value, being provided for this purpose. The engine control panel carries a starting switch, meters and gauges. Starting is effected by motoring the generator from a battery, an operation which can be carried out without applying power to the motors.

The control equipment, which comprises the electromagnetic contactors, air-operated reversing switch, field diverting resistance, voltage regulator and various relays is mounted on a frame in the rear compartment, as shown in the illustration opposite. In the event of failure of the oil pressure or excessive cooling water temperature the engine is shut down automatically.

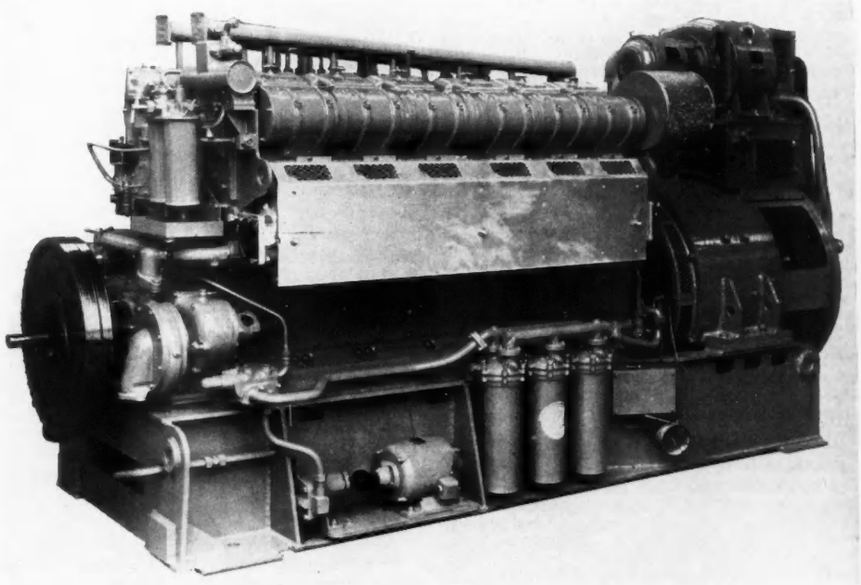
Each axle carries a motor, which is mounted in journal bearings and is nose-suspended through links and Silentbloc bushes from the centre cross-bearer. The motors themselves are of conventional box-frame construction with Class B insulation throughout.

The brakes are vacuum-operated, a motor-driven exhauster being installed in the rear compartment for this purpose. A brake cylinder is mounted on each bogie and the rigging is of the clasp type with fully compensated leverage. The locomotive's brakes can be independently controlled during shunting.

The auxiliary equipment includes a Hamworthy air compressor with a capacity of 6·5 cub. ft. of air per minute, which is belt-driven from the engine and provides air for sanding the wheels, blowing the horn and operating the reversing switch.



410-h.p. Diesel-electric locomotive for 3 ft. 6 in. gauge. The engine has been de-rated from 500 h.p. for operating in high ambient temperatures and humidity.



Paxman Diesel engine coupled to B.T.H. generator.

LAUNCHES AND TRIAL TRIPS

M.S. "VIDALAND."—Single-screw cargo vessel, built and engined by Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, for Ångfartygs A/B Tirfing-Svenska Orient Linien, Gothenburg, Sweden. Main dimensions: 400 ft. between perpendiculars by 57 ft. 8 in. by 25 ft. 3 in. to main deck; deadweight capacity, 5,800 tons on a draught of about 23 ft. 7 in. B. and W. seven-cylinder single-acting Diesel engine, developing 6,700 i.h.p. Speed, 16·5 knots, fully loaded. Launch, November 17.

M.S. "TERN."—Single-screw refrigerated-cargo vessel, built by Cook, Welton and Gemmell, Ltd., Beverley, Yorkshire, for the General Steam Navigation Co., Ltd., London, E.C.3. Main dimensions: 196 ft. 6 in. between perpendiculars by 34 ft. by 19 ft. 3 in. to main deck; deadweight capacity, 760 tons on a draught of 13 ft.; refrigerated-cargo capacity, 44,500 cub. ft. Five-cylinder two-stroke Diesel engine, developing 800 b.h.p. at 250 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Speed on trial, 12·3 knots. Trial trip, November 19.

S.S. "HADRA."—Single-screw oil tanker, built by Smith's Dock Co., Ltd., South Bank-on-Tees, for the Anglo-Saxon Petroleum Co., Ltd., London, E.C.3. Main dimensions: 530 ft. between perpendiculars by 69 ft. 3 in. by 39 ft.; deadweight capacity, about 18,000 tons on a draught of about 29 ft. 6 in. Double-reduction geared steam turbines and two Foster Wheeler oil-burning boilers, constructed by R. and W. Hawthorn, Leslie & Co., Ltd., Newcastle-upon-Tyne, and installed by the shipbuilders. Service speed, 14½ knots. Launch, November 20.

S.S. "SIR DAVID II."—Single-screw self-trimming collier, built by Hall, Russell & Co., Ltd., Aberdeen, for the North Thames Gas Board, London, W.8. (Managers: Stephenson Clarke, Ltd., London, E.C.3.) Main dimensions: 320 ft. between perpendiculars by 46 ft. by 22 ft. 4 in.; deadweight capacity, 4,600 tons on a draught of 20 ft. Triple-expansion steam engine of reheat design, developing 1,275 i.h.p. in service, constructed by the North Eastern Marine Engineering Co. (1938), Ltd., Sunderland. Steam generated by two oil-fired cylindrical boilers. Launch, November 20.

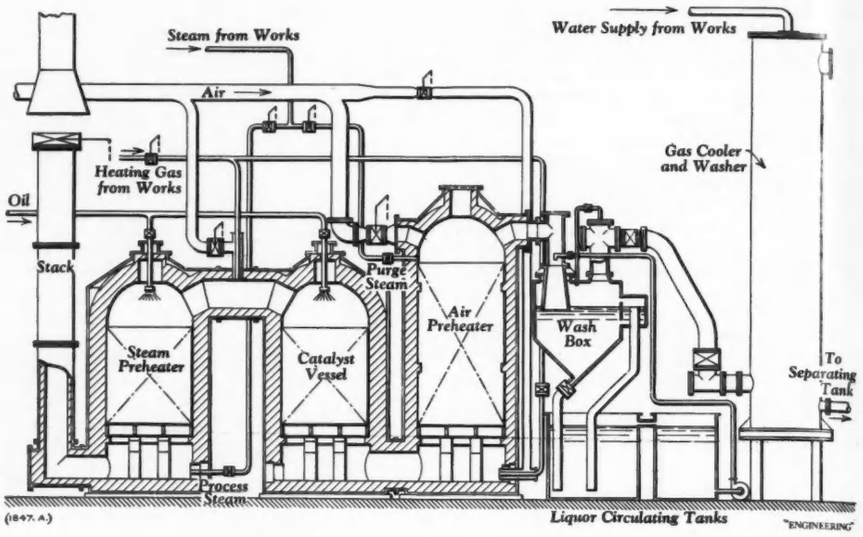
M.S. "SHEAF ROYAL."—Single-screw oil tanker, built by Joseph L. Thompson & Sons, Ltd., Sunderland, for the Sheaf Steam Shipping Co., Ltd., Newcastle-upon-Tyne. Main dimensions: 516 ft. between perpendiculars by 73 ft. by 41 ft. 1 in.; deadweight capacity, 18,275 tons on a draught of 30 ft. 6 in. Six-cylinder opposed-piston oil engine, developing 7,750 b.h.p. at 103 r.p.m. in service, constructed by William Doxford & Sons, Ltd., Sunderland. Service speed, 15 knots. Trial trip, November 20.

M.S. "MARIANNE."—Single-screw oil tanker, built and engined by the Eriksbergs Mek. Verkstads Aktiebolag, Gothenburg, Sweden, for the Aktiebolaget Navigare, Stockholm, Sweden. Main dimensions: 526 ft. between perpendiculars by 69 ft. 6 in. by 39 ft. 3 in.; deadweight capacity, about 18,000 tons on a draught of 30 ft. 5 in.; oil-tank capacity, 860,988 cub. ft. Eriksberg-B. and W. nine-cylinder single-acting two-stroke Diesel engine, developing 9,000 i.h.p. and a speed of 15¼ knots, fully loaded. Delivered, November 30.

M.S. "PINDAR."—Single-screw cargo vessel, built by Short Brothers, Ltd., Sunderland, for the Parana Compania de Vapores S.A., Panama. Main dimensions: 450 ft. between perpendiculars by 61 ft. by 38 ft. 8 in. to shelter deck; deadweight capacity, about 10,200 tons on a mean summer draught of 26 ft. 6 in. Eight-cylinder single-acting two-stroke oil engine, developing 5,600 b.h.p., constructed by Sulzer Brothers, Ltd., Winterthur, Switzerland, and installed by the North Eastern Marine Engineering Co. (1938), Ltd., Sunderland. Service speed, 14 knots. Launch, December 7.

M.S. "BORDER LASS."—Single-screw oil tanker, built and engined by William Doxford & Sons, Ltd., Sunderland, for the Lowland Tanker Co., Ltd., Newcastle-upon-Tyne. Main dimensions: 515 ft. by 69 ft. 6 in. by 37 ft. 5 in.; deadweight capacity, 16,000 tons on a draught of 30 ft. Doxford six-cylinder opposed-piston oil engine. Launch, December 8.

M.S. "THORPE GRANGE."—Single-screw cargo vessel, built by Bartram & Sons, Ltd., Sunderland, for the Houlder Line, Ltd., London, E.C.3. Main dimensions: 445 ft. 10½ in. between perpendiculars by 61 ft. 9½ in. by 40 ft. 2 in. to upper deck; deadweight capacity, 11,980 tons on a draught of 29 ft. Wallsend-Doxford four-cylinder opposed-piston heavy-oil engine, developing 4,200 b.h.p. at 114 r.p.m. in service, constructed by the Wallsend Slipway and Engineering Co., Ltd., Wallsend-on-Tyne. Speed, 13¼ knots. Launch, December 8.



SEGAS PROCESS FOR MAKING GAS FROM OIL

60 TONS OF COAL SAVED DAILY

Experiments begun in 1947 in the central laboratories of the South Metropolitan Gas Company, Old Kent-road, London, S.E.15, have led to the discovery of a process for making a gas of standard quality from a residual fuel oil by causing the oil to react with steam at high temperatures in the presence of a lime and magnesite catalyst.

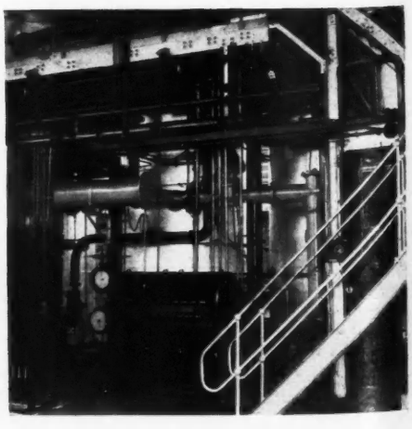
The process has grown from these laboratory experiments and subsequent pilot-plant tests to a full-scale commercial plant producing up to 800,000 cub. ft. of gas a day, and thereby effecting a daily saving of some 60 tons of coal. The plant which we saw in operation recently is installed at the Bell Green Gasworks, Lower Sydenham, and has been designed jointly by engineers of the South Eastern Gas Board, who took over the responsibility for the work on the nationalisation of the gas industry, and the Power-Gas Corporation, Limited, Stockton-on-Tees.

Briefly, the main function of the Segas catalytic gasification process, as it is called, is to cause steam to react at temperatures in the region of 1,000 deg. C. (1,830 deg. F.) with some of the excess carbon present in the petroleum hydrocarbons of the fuel oil, thus producing hydrogen and carbon monoxide. The remainder of the excess carbon is deposited and subsequently burned to provide the heat necessary for the process to be continuous. The resultant gas consists mainly of carbon monoxide, methane and hydrogen and its composition is described as being similar to that of ordinary town gas.

OIL VAPORISED BY STEAM

The plant, a diagram of which is shown above, consists of three cylindrical vessels of mild steel lined with brick. They are, respectively, a steam preheater, a catalyst vessel and an air preheater. The first and second each have an overall diameter of 8 ft. 6 in., and a height of 16 ft. 6 in., while the air preheater has an overall diameter of 7 ft. 9 in. and a height of 21 ft. 6 in. Process steam enters near the base of the steam preheater and is heated to a high temperature during its passage upwards through the heated chequer brickwork. At the top of the vessel the steam meets a spray of oil and vaporises it, and the mixture of steam and oil vapour passes into the adjoining catalyst chamber where further oil is taken up from a second oil spray. The mixture of steam and oil vapour passes down through the rows of stacked rings of catalyst in the catalyst chamber where the reaction takes place at a temperature in the neighbourhood of 1,000 deg. C. Some of the carbon of the oil is deposited as soot on the surface of the catalyst rings but the main products of the reaction, gas and tar vapour, pass up the adjacent air preheater giving up their heat to the chequer bricks in that chamber. Finally, the gas bubbles through the wash box and goes on to a Lymn washer and subsequently to Livesey washers and meters. The tar, which is the only by-product made during the reaction, is deposited in the wash box and subsequently withdrawn.

The flow from "left to right" of the apparatus, which we have just described, lasts normally for some four minutes. During this time heat has been absorbed by the air preheater, and tem-



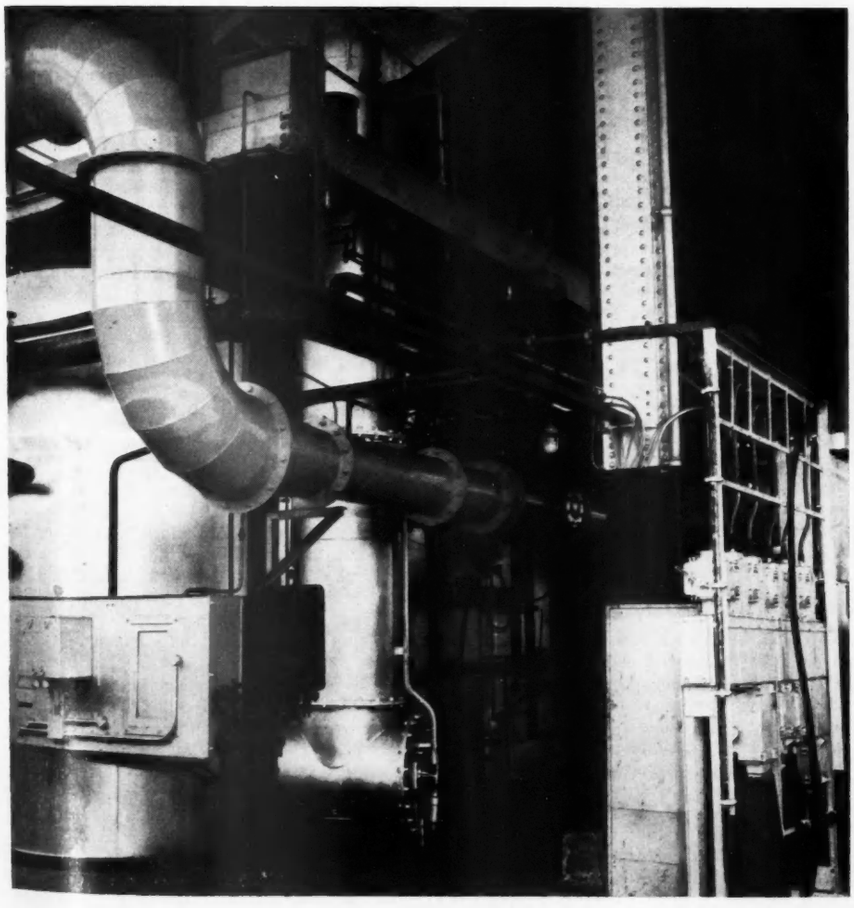
Mechanical operator for controlling the sequence of valve changes.

peratures in the catalyst chamber and steam preheater have fallen. The supplies of steam and oil are then shut off, the gas off-take valve is closed and compressed air entering at the top of the air preheater is blown backwards through the plant. It takes up heat in the air preheater, burns off the carbon deposited on the catalyst and thereby heats up the chequer brickwork in the steam preheater on its way to the stack. The flow, just described, from "right to left" of the apparatus lasts about two minutes. Thus the duration of the entire cycle of operations is six minutes and the valves controlling the steam, oil and air are opened and closed automatically in the necessary sequence by the shaft of a mechanical operator. This is driven by an electric meter and the vertical rods which open and close the various valves are operated by a series of adjustable cams on the shaft.

FUEL OIL

The fuel oil used in the process, some 130 gallons of which are consumed per hour, has a viscosity of 200 seconds Redwood No. 1 at 100 deg. F., a specific gravity of 0·960 at 60 deg. F., and a calorific value of 180,000 B.Th.U. per gallon. The steam used is given as 2,600 lb. per hour and the air as 9,500 lb. per hour. The gas made per gallon of oil totals 1·15 therms or about 230 cub. ft., and its calorific value ranges between 480 and 508 B.Th.U. per cub. foot.

The Segas plant first started making gas in February, 1953, and we were informed that the catalyst had not been changed since it was originally installed.



View of reaction vessels showing, from left to right, steam preheater, smoke stack, catalyst vessel and air preheater.

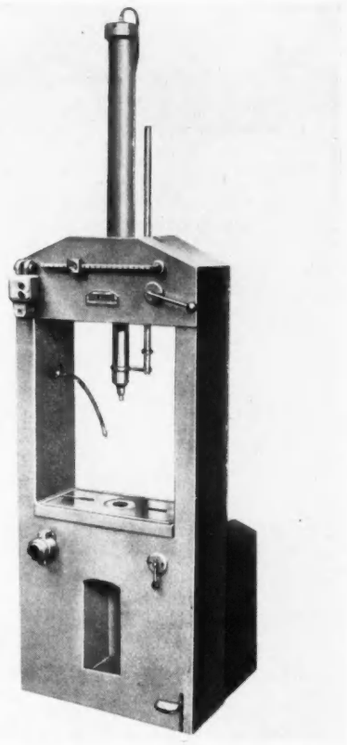
HYDRAULIC PRESSES OF 9, 20 AND 50 TONS

Variable Speed and Pressure Control

A range of light hydraulic presses having a control device which limits the working pressure during any stroke to a pre-set value, has been introduced by W. H. Marley and Company, Limited, New Southgate Works, 105, High-road, London, N.11. The ram of each press has a full travel almost equal in length to the height of the frame opening. The presses are made in three sizes with maximum downstroke loads of 9 tons, 20 tons and 50 tons, and are capable of push-and-pull operations such as broaching, piercing, embossing, deep-drawing and extrusion. The presses are of all-steel welded construction and provide a choice of three operating speeds in each direction, with either foot or hand controls.

Whichever method of control is used, when the controller is released the ram stops in whatever position it occupies at the time. This result is achieved by means of a non-return valve which prevents the escape of hydraulic fluid from the cylinder. Since, therefore, pressure is maintained on both sides of the double-acting piston, sinking of the ram under gravity is eliminated and its position held indefinitely.

The use of a tripping device, set to limit the return of the tool holder, saves time during repetition work. In this way the length of stroke can be shortened and the delay between successive operations reduced to a minimum. A second limit switch controls the extent of the ram's downward movement, so avoiding the danger of over-running, and protecting the tool and workpiece from damage. A stroke length of 1 ft. 6 in. is available in the 9-ton model and of 2 ft. in the two heavier versions.

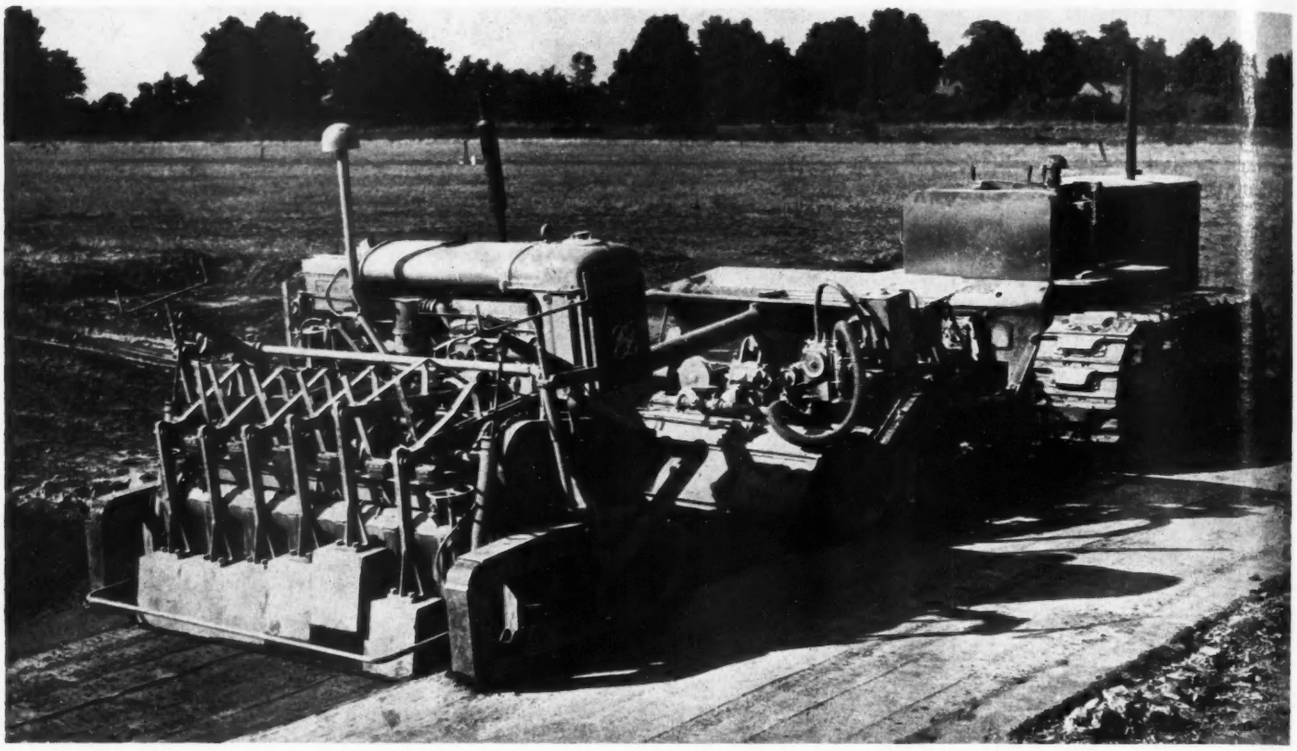


The downward force exerted by this hydraulic press can be limited by a safety valve. At the top of the frame can be seen a graduated scale, pivoted at one end where it is connected to the valve, and carrying a weighted cursor the position of which regulates the pressure.

There are six speeds on each press: three approach and three return. Speed control is obtained by means of a three-cylinder pump, the pistons of which act in parallel and may be cut out in turn. Thus the highest speed is given when three cylinders are in use; the lowest when the flow of hydraulic fluid is provided by one cylinder alone. A three-phase 50-cycle 440-volt motor drives the pump at a constant rate. When two pistons are cut out, the total horse-power of the motor is transmitted through one piston and consequently the highest pressure is given at the lowest ram speed and is approximately in inverse proportion to it. The smallest model of the press, for example, has a maximum working load of 9 tons which corresponds to a ram speed of 2 ft. per minute; accordingly, when the speed of the ram is increased to its ultimate 5½ ft. per minute, the load falls to a little above 3 tons.

The upward pull is a third of the downward force. Thus the return speed is three times the forward value. This characteristic provides a convenient quick-return motion but, in addition, when the presses are operated at the slower rates, the speed control handle can be used to give a fast approach or return.

The pressure controller, which is visible in the illustration, is situated at the top of the frame and consists of a pivoted, graduated scale on which slides a cursor. The cursor can be locked in any position and, for a given setting, the moment of its weight about the pivot is balanced by a corresponding hydraulic pressure acting through a spring-loaded valve. Excess pressure uncovers a vent through which the hydraulic fluid is released.



Soil-stabilising equipment : compactor, cement spreader, pulveriser and mixer, and tractor.

SOIL STABILISATION

SINGLE-PASS EQUIPMENT FOR LAYING SOIL-CEMENT ROAD BASES

In recent years, soil-cement stabilisation has made great progress as a means of constructing road foundations. There has been a considerable increase in its use, not only for housing-estate roads, but primarily for laying sub-bases for main roads which are to carry heavy traffic. Both by practical experience and by laboratory investigations, it has been demonstrated that a wider range of soils can be successfully treated than at first seemed possible. Nevertheless, the use of the process has so far been restricted, at least in the United Kingdom, by the absence of suitable plant. The marketing of British-made equipment should do much to bring about a more widespread use of this most economic method of laying road formations.

The equipment illustrated has been designed to lay, at a single pass, a stabilised and consolidated soil formation 6 ft. wide by 8 in. deep at a speed of between 2 ft. and 10 ft. per minute. Shown in the illustration above being towed behind a tractor, it consists of three machines, the first two being carried on the same undercarriage. The unit immediately behind the tractor is the pulveriser and mixer which also embodies the water-spraying apparatus; combined with this unit is the cement spreader. The third unit, an independent self-powered machine, the compactor, completes the equipment, which has been designed and is made by Rotary Hoes, Limited, Horndon, Essex.

As was pointed out by Mr. D. J. Maclean of the Road Research Laboratory, in a paper read before the Pavings Development Group last November, single-pass soil-stabilising machines have several advantages over multi-pass machines. An immediate advantage is the ability which permits operations to be started and stopped as required; this means that work can be confined to a definite number of working hours each day, in contrast to operations with multi-pass machines for which any over-estimation of the area to be processed leads to the final compaction being carried out under difficult conditions at the end of the day. Single-pass machines also virtually eliminate hazards due to weather conditions, particularly the onset of heavy rain, since work can be stopped as conditions become unsatisfactory. Furthermore, such equipment usually gives a better distribution of cement in the stabilised layer than is obtained with multi-pass machines; this is partly due to the design of the rotary tiller but is also due to the segregation of the cement and soil which occurs with repeated passes.

PULVERISER AND MIXER

A tractor of between 50 and 90 h.p. is required to haul the equipment, and the combined pulveriser, mixer and cement spreader is fitted with a heavy-duty draw-bar with a universal coupling block suitable for fixing to this class of tractor. It would be very desirable if a tractor could be used in which the overall track width was less than the processed width – in the case of the present equipment, 6 ft. Power is transmitted directly from the tractor power take-off by a universal coupling and torque shaft to a bevel gearbox. The gearbox is fitted with two pinions giving forward and reverse rotation, and from the extended pinion shaft twin V-belts are used to drive the water pump and the cement spreader. For safety, a friction clutch has been provided in the drive to the rotor, the final drive from the jackshaft to the rotor being by a roller chain of 1·5 in. pitch.

The rotor is straight bladed. Its length over flanges is 72½ in. for processing a nominal width of 6 ft. The pulverising blades have hardened cutting surfaces and are adjustable for wear, each blade being secured by holding bolts. Two side cutters are fitted in each of the outer flanges to protect the blade ends. A range of rotors is available to suit various conditions of work, and a sectional rotor, for processing widths of 2 ft., 4 ft. or 6 ft., is also available. The rotor shield is made to take detachable diaphragms for different widths of processing, and side screens for retaining the pulverised soil can be adjusted to enclose the rotor for working depths between 4 in. and 8 in.

The whole machine can be raised and lowered hydraulically to provide either an 8-in. cut or a 10-in. ground clearance below the rotor. Flexible hoses are provided to carry the hydraulic pressure from the pump and valve chest on the tractor to the two lifting cylinders. The screw-operated depth-control columns are arranged so that the machine may be set manually to work at a predetermined depth ; they can be adjusted for depth while the machine is moving.

The maximum output of the water system is 50 gallons per minute. A suction pipe spans the full width of the machine and, from this pipe, water enters the system through a quick-action gate valve coupled to the suction inlet of a centrifugal water pump. A regulating valve controls delivery from the pump. The spray boom located on the rotor shield is so arranged that the spray from the nozzles is directed on to the rotor, the effective width of the spray being adjusted for the width of processing employed. The machines can be used with either water tankers or directly off hydrants ; in either case they have an identical layout, but those supplied

for use only off a hydrant are not provided with a pump.

CEMENT SPREADER

The cement spreader is mounted on the torque-shaft tube of the pulveriser, and consists of a hopper supported on a cylindrical chamber which houses a metering rotor. In the bottom of the hopper is an agitator which distributes the cement to the meter, whence it is discharged into the soil. During its fall, the cement is suitably guarded from splash and wind.

Driving power for the spreader is taken from the rear end of the bevel gearbox by V-belts, through a chain-driven reduction gear and worm to a slow-speed jackshaft. The final drive to the agitator and to the metering rotor is by roller chain. If necessary, the transmission can be disengaged at a dog clutch in the wormshaft. Both the agitator and the metering rotor have a remote plain journal bearing at each end. The bearings are sealed to prevent the entry of cement.

The hopper is 6 ft. long by 21 in. wide at the top and has a capacity of six bags of cement (670 lb.). At the base of the hopper is a narrow rectangular aperture leading directly into the metering chamber. Side brackets on each side assist with handling the bags of cement, and detachable guard rails prevent the bags from falling into the hopper, sections of which may be sealed off by baffles according to the width of soil being processed.

The agitator, located above the aperture leading to the metering chamber, is designed to prevent any choking across the aperture and to distribute the cement evenly to the metering rotor. This rotor is housed in a 6½-in. diameter tube in which it is a running fit. In the top of the tube is an aperture of the same dimensions as the base of the hopper to which it is attached. Six blades divide the rotor into equal compartments which carry the cement from the upper aperture to a similar aperture on the underside, through which it is discharged. The cement output may be varied over a wide range – between 3 per cent. and 20 per cent. by volume of the soil being treated.

COMPACTING BY DROPPING CAST-IRON BLOCKS

The compactor is arranged as a single towed unit. Driving power is provided by a Perkins Diesel engine developing 48 h.p. at 1,500 r.p.m. The weight of the working machine is 4·2 tons and the compacting depth is 8 in. over the treated width of 6 ft.

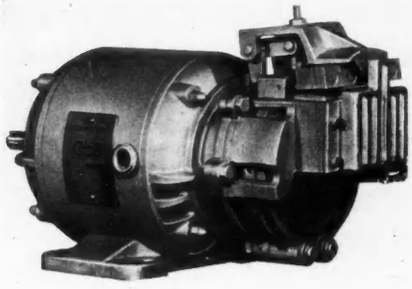
From the engine, power is taken through a 12-in. heavy-duty wet clutch and a universally-jointed shaft to a reduction gearbox, the reduction gear being engaged by a sliding pinion. From the gearbox the drive divides, part being taken to a distribution rotor and part to the camshaft which operates the compacting blocks. The function of the rotor is to impart a final mixing to the top soil and to trowel the soil/cement backwards towards the compacting unit. The compactor consists of six 5-cwt. cast-iron blocks so mounted that they are lifted by cams and then allowed to drop on to the surface to be consolidated. An adjustable screed located between the rotor and the blocks controls the amount of soil reaching the compactor.

The machine is carried on a pair of undriven tracks patented by the makers. The long length of the plates, as compared with the overall size of the track, as shown in the illustration, has been selected to give as small a tearing action as is possible. The tracks may be lowered and raised by two hydraulic cylinders working in tandem and each track can be adjusted by means of hand screws. These screws form the method of depth control for the compactor, which has a working road speed of between 2 ft. and 10 ft. per minute.

All the controls are grouped together at the rear of the machine. They consist of an engine clutch lever, the control for hydraulically raising and lowering the compactor, and a lever for moving the sliding pinion in the gearbox. Screw controls are also provided for the fine adjustment of the track height and for the rear screed board.

The towbar is designed so that the compactor may be conveniently towed either behind the pulveriser or immediately behind the tractor. The overall dimensions of the compactor are : width, 9 ft. ; length, 11 ft. 8 in. (including the 6-ft. long towbar).

★ ★ ★



MAGNETIC BRAKE FOR ELECTRIC MOTORS

Brook Motors, Limited, Empress Works, Huddersfield, have designed a magnetic brake for mounting direct on small electric motors, as shown in the accompanying illustration. It consists of a cast-iron backplate, which is mounted on the motor, and a 4-in. diameter drum which is connected to an extension of the shaft.

When the electromagnet, which forms the operating unit, is energised, its armature actuates an arm which, in turn, moves a crosshead and thus depresses a toggle joint. This toggle acts against the spring which holds the brake shoes on to the drum and releases them when the current is switched on. The arm can be adjusted by a screw so that the gap between the magnet faces is maintained constant, thus ensuring that the coil will " pull in " within its stated voltage range and compensating for the wear of the brake lining. The brake is normally " on " when the current is off, so that if a fault or failure of supply occurs it is applied automatically. The brake has a maximum dynamic frictional torque of 10 lb.-ft. and is suitable for connection to either the 200/250 volt or 350/440 volt alternating-current mains.

★ ★ ★

ELECTRIC SUBMERSIBLE PUMP

3·3-kV Motor Eliminates Special Starting Equipment

Electrically-driven submersible pumping units, which were originally developed some 30 years ago for marine salvage work, have since been widely employed for a variety of other purposes, including mine de-watering. They have generally consisted of a small diameter squirrel-cage motor, which is directly coupled to a pump and is connected to the 440/550-volt mains. Hayward-Tyler and Company, Limited, Luton, have, however, developed a set in which a 3·3-kV motor is employed. This has the advantage that no special starting equipment is required for the set, and, in addition, the short-circuit current is reduced.

This unit, which is illustrated herewith, consists of a 350-h.p. 3/3·3-kV double-cage four-pole three-phase motor, which is directly coupled to an eight-stage pump with an output of 1,000 gallons per minute against a total manometric head of 775 ft. The motor is generally of all-steel construction and is fitted with a thrust bearing assembly of the Michell type as well as with under-water white-metal bearings. In mechanical design it is similar to that of the firm's low-voltage submersible motors. It is, however, rather larger since, owing to the higher voltage, more stator conductors are required.

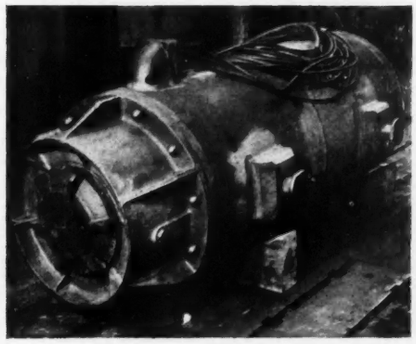
The windings are insulated with polyvinyl chloride and are brought out through a flame-proof coupling on the outside of the stator casing. They are cooled by the movement of the rotor which forces water from the lower end, where the maximum heat transfer occurs, along the surface of the skid ring. Hydraulically, the motor is completely isolated from the well water, and to give added protection a corrosion-insulating solution is injected before lowering the unit into the well.

As regards electrical design, the motor is arranged to operate satisfactorily with a ± 6 per cent. variation in voltage and a ± 2½ per cent. variation in frequency, while 43 per cent. of the starting torque can be obtained with a voltage of 3,150 volts at standard frequency. With an input of about 274 kW and a speed of 1,470 r.p.m. the overall efficiency is some 69 per cent. at a power factor of 0·83. The direct-on-line starting time is 3½ seconds, the starting current being 2·5 times the full-load current and the starting torque 43 per cent. of the full-load torque.

In addition to the advantages already mentioned, the use of a high voltage enables the cost and weight of the connecting cables to be reduced, even when account is taken of the thicker insulation necessary. The electrical losses are also less and there is a saving in the cost of the operating contactors and overload protection equipment.

The pump is a standard multi-stage unit, which is mainly constructed of gunmetal and stainless steel, the impellers and vanes being polished to minimise friction. The total thrust load developed by the eight 12½-in. diameter impellers is 20,000 lb.

The unit illustrated, which is to be installed in a shaft 730 ft. deep and 17 ft. in diameter for de-watering a mine in the Scottish Division of the National Coal Board, is 12 ft. 3 in. overall, of which the motor occupies 6 ft. 6 in. It weighs 5 tons, of which three-fifths are accounted for by the motor.



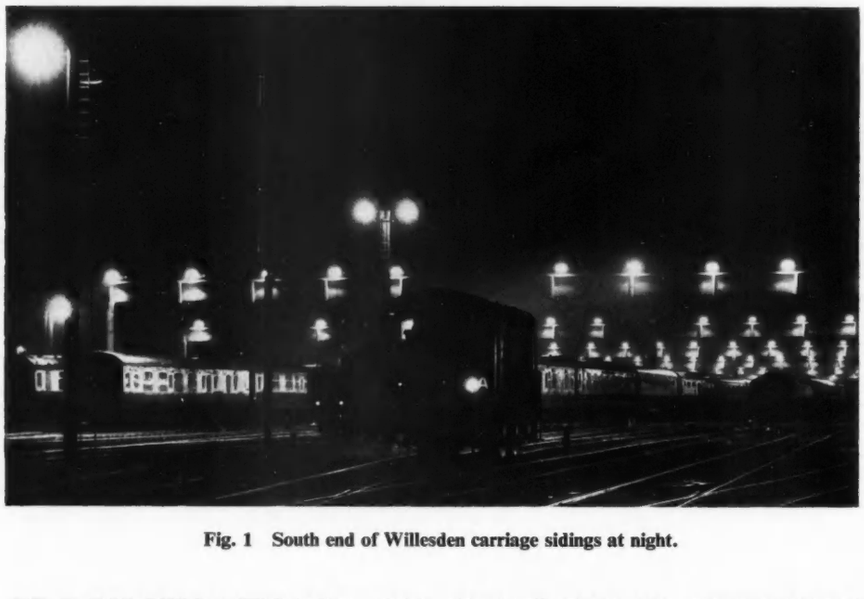


Fig. 1 South end of Willesden carriage sidings at night.

ILLUMINATION OF RAILWAY SIDINGS

LIGHTING FITTINGS SUPPORTED ON CONCRETE GANTRIES

To illuminate railway sidings at night satisfactorily light must be provided between rows of vehicles on closely-spaced tracks without obstructing the limited clearance between the lines with poles. To overcome this difficulty when the storage and marshalling sidings connected with the new carriage shed of the British Railways, London Midland Region, at Willesden, were being planned, the Civil Engineer's Department decided to adopt a system of light sources located over the spaces between adjacent sidings, to align these parallel with the tracks and to mount them on gantries provided with continuous protected walkways, from which inspection and maintenance could be carried out. This has the advantage, over the method of suspending the lighting fittings from catenaries spanning the tracks, of facilitating access.

Fig. 3 Interior of carriage shed.

The 11 gantries erected for this purpose at Willesden are of prestressed reinforced-concrete construction, and are spaced at 180 ft. They are built up of standard units and consist of from one to four spans which vary from 51 ft. 8 in. to 82 ft. 2 in. and cross from four to seven tracks. The lighting units, which were manufactured by the General Electric Company, Limited, Kingsway, London, W.C.2, are a modified version of that firm's " Uniway " lantern, and each houses a 200-watt tungsten filament lamp. These lanterns, of which there are 333 in all, are mounted back to back in rows on each side of the walkways, as shown in Fig. 2, the supports being cranked outwards, so that the areas lighted overlap under the gantry. Shadows beneath the spans are thus avoided.

The supports themselves are of steel tube which are so arranged that, after three screws have been slackened with the fingers, the lantern can be turned inwards, the front opened and the lamp changed or other maintenance performed from the walkway.

The lights are " ripple-controlled " from the central signalbox in three longitudinal blocks, although switches on the gantry walkways enable groups of lanterns to be individually isolated.

Tests of various methods of focusing and directing the beams have been made. As a result, it was found that although maximum uniformity of lighting would have been obtained between the gantries by focusing on a point directly below the next gantry, the staff working in the sidings would have been exposed to disagreeable glare. The system finally adopted was therefore to focus each lantern on a point on the ground half way between two gantries in a direction parallel with the tracks. With this arrangement there is no glare between the tracks, owing to the fact that the angle at which the lanterns are set prevents the light source from being seen at normal angles of view. There is, moreover, no impression of patchiness and variations can only be detected by a light meter.

In fact, the installation provides a safe walking light in the confined spaces between coaches

Fig. 2 Lantern supported on prestressed concrete gantry.

standing on the adjacent tracks which form the 22 sidings and extend for some 640 yards. Persons or objects in these spaces are clearly silhouetted and the hand lamps used for signalling can be distinguished without difficulty. Points for charging and topping up batteries, supplying gas and water, and for pre-heating stock are available between the tracks and, as these can now be clearly seen, servicing has been rendered both easier and safer.

As shown in Fig. 3, the central portion of the new carriage shed is lighted by 24 fittings, of General Electric manufacture, each of which contains one 250-watt mercury lamp, one 500-watt tungsten lamp and two 5-ft. 80-watt daylight-colour fluorescent tubes. The combination of mercury and tungsten lamps gives an acceptable quality of general lighting, while the fluorescent tubes on the sides of the fittings illuminate the walkways from which access is obtained to the roofs of the carriages. Raising and lowering gear enables the fittings to be inspected at ground level.

★ ★ ★

HIGH AND LOW PASS FILTERS WITH FERROXCUBE CORES

By using Ferroxcube pot cores for the inductances of their high and low pass variable cut-off filters Mullard, Limited, Shaftesbury-avenue, London, W.C.2, have considerably reduced the sizes of these components and have obtained excellent attenuation characteristics. This compactness has been assisted by employing a design known as the synthetic method, which enables the optimum performance to be obtained from a given number of elements. The capacitances required are reduced to such an extent that small silver-mica condensers of high stability and good power factor can be used.

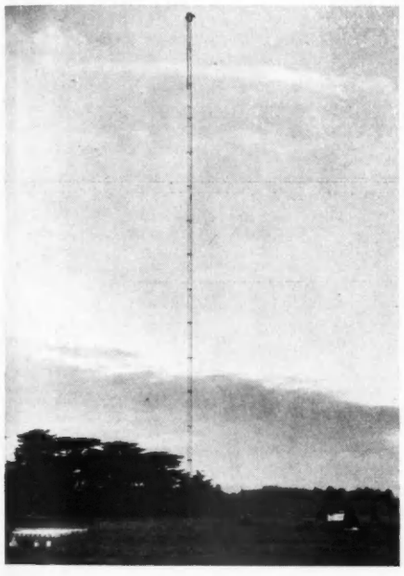
The filters have an input and output impedance of 600 ohms, although the actual sections are designed for a value of 25,000 ohms. The high-pass cut-off frequencies are 440, 660, 990, 1,480, 2,222, 3,333, 5,000, 7,500, 11,250 and 16,800 cycles and the low-pass 400, 600, 900, 1,350, 2,025, 3,040, 4,500, 6,830, 10,250 and 15,400 cycles. A single switch enables any frequency to be selected and by connecting the high and low-pass units in tandem and varying the frequency the filters can be used for sampling and frequency analysis. The cut-off frequencies of the high and low-pass sections are slightly different to enable non-overlapping samples to be taken. Stopband attenuation is 50 decibels at 0·8 times the cut-off frequency for the high pass and 1·25 times for the low pass sections. Beyond these limits the attenuation increases very rapidly. The high-pass band attenuation is 3 decibels $\pm$ 1 decibel, while that of the low-pass band is 2 decibels $\pm$ 1 decibel.

STRUCTURAL TESTS ON TUBULAR WELDED MASTS

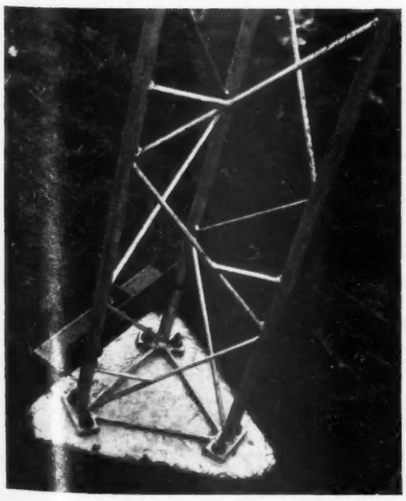
TORSION AND WIND LOAD

For a number of years many lightweight welded radio masts up to 120 ft. in height have been assembled from standard 10-ft. sections bolted together. These masts, designed and built by British Insulated Callender's Construction Company, Limited, 21, Bloomsbury-street, London, W.1, have been designed to withstand a wind velocity of 100 miles an hour and a load of 1,000 lb. at the masthead, but recent tests have shown that the masts have, in fact, large reserves of strength.

With comparatively small masts of this class it is almost impossible during erection to control the stay tensions in accordance with design requirements and, consequently, the design has to take into account the possibility of maladjustment. It therefore follows that the true assessment of the strength of this class of mast can only be determined by field tests.



150-ft. tubular welded mast erected for testing. Masts of this type are used for radio and survey work.



Base of mast "A" showing the form of bracing used. The short horizontal members on the near face are the climbing rungs.

The masts have been found to have many applications, but numerous inquiries have been received as to the possibility of extending the height. Such an inquiry was received recently from the Decca Navigator Company, Limited, who wanted 150-ft. lightweight masts for use in connection with survey work in the Sahara Desert. It was therefore decided to carry out field tests on the masts and two, 150 ft. high, were erected and subjected to torsion, wind loading and electrical tests at Taplow Court, Buckinghamshire, headquarters of British Telecommunications, Limited. One of the masts is shown below.

CONSTRUCTION AND ERECTION

The masts, which are triangular in cross-section, are made up of standard sections, 10 ft. long, which have built-in climbing rungs, guy attachment plates and jointing studs. The three vertical leg members, which have centres 12 in. apart, are of 1 $\frac{1}{16}$ in. o.d. by 11 s.w.g. class "B" tubing, braced by $\frac{3}{8}$-in. diameter mild-steel rods. The climbing rungs, 4$\frac{1}{2}$ in. long, are incorporated on one face of each section at intervals of 1 ft. The bracings and rungs are fixed in position by arc welding and all sections are hot-dip galvanised after fabrication. Details of the bracing can be seen in the lower illustration, which also shows the method adopted for incorporating the climbing rungs in the framing.

The feature of the masts is the light weight – less than 7 lb. per foot. Masts are stayed at the 30-ft. level and thereafter at intervals of 20 ft., but guy attachment plates are provided at the top end of every section to obviate any mistakes in assembly.

The masts are designed for easy erection with the minimum of labour. No site concreting is required, except in very bad ground where it may be necessary to set picket stakes in small concrete blocks or muffs. If the mast is to carry a head load, provision has to be made for a back-stay anchorage which would involve the only excavation work necessary.

At the Taplow Court site one of the two masts was erected on a dished baseplate, which had an area of 240 sq. in. and successfully took the total down-thrust of the mast and stays, amounting to approximately 4$\frac{1}{2}$ tons. The more usual figure is between 3 and 3$\frac{1}{2}$ tons, but the increase was due to the unusually high loads employed in the various tests that were carried out. For use in the Sahara Desert, where there are varying types of ground, special foundations and anchorages have been designed for conditions ranging from solid rock to sand.

There are two methods of erection: one employing a falling derrick and the other a 20-ft. long light-alloy pole. The latter method, which was used at Taplow, allows erection to proceed section by section in the vertical. Alternatively, the mast is completely assembled along the ground with the base correctly located and with a temporary arm (which is initially vertical) bolted to the mast; suitably hauling on the end of this arm enables the mast to be elevated into an upright position using the stays to steady it during the course of erection. Both these methods require a team of six men and enable a mast of 150 ft. to be erected in approximately eight hours.

LAYOUT OF TEST SITE

Two masts were spaced 125 ft. apart and stayed at seven levels. Mast "B" which was later used by the Decca Navigator Company for electrical tests on their aerial array, had three post insulators, one per leg of the mast, inserted between the bottom standard 10-ft. section and the baseplate. Lead packings were used above and below these insulators. The stays on this structure were standard, that is, three stays to each stay level, all of 7/14-s.w.g. steel-wire rope of 45 tons per square inch u.t.s., with the exception of the head "back" stay which was of 7/19 construction of 110/120 tons per square inch. For the electrical tests, glass-rod insulators were inserted in all stays. Mast "A," which was subjected to torsional tests, was similarly stayed up to the 130-ft. level, but the head stays were varied in number and size for the three mechanical tests.

Torsion Tests.—For the two torsion tests on Mast "A" a horizontal member was bolted to the head of the mast so that it projected approximately 3 ft. on either side. A horizontal load was applied at right angles to one end of this cross arm so applying a torque to the mast, and the deflection was measured against the applied load. Theodolites were used to note the movement of calibrated scales fixed at appropriate points on the mast. To restrict angular movement under torsional load, twin head stays were used in each of the three directions, with a short moment arm of 2 ft. between each guy. The results of the test are given in Table I.

The whole of the test was repeated with only single stays, and the results are given in Table II. Comparison of the figures in Tables I and II shows the value of the second head stay.

Wind-load Test.—A test to reproduce the condition of wind force by a system of loading between the two masts was carried out by attaching ropes at various levels to Mast "A," taking them over pulleys at corresponding levels on Mast "B," and adding dead loads. The results of this test are shown in Table III, below.

A load of 2,000 lb. was to have been applied to the masts at the 150-ft. level and measurements taken of the deflection at the mastheads, but owing to the premature failure of some of the ancillary test equipment only 1,700 lb. could be applied. The test suggested, however, that the masts could easily take a 2,000-lb. head load without being crippled.

TABLE I. *Torison Test, Twin Head Stays.*

Torque, lb.-ft.	Rotation, deg.	Torque, lb.-ft.	Rotation, deg.
450	3	1,200	7
600	4	1,350	7
750	5	1,500	7
900	6	1,650	8
1,050	6·8	1,800	8

TABLE II. *Torsion Test, Single Head Stays.*

Torque, lb.-ft.	Rotation, deg.	Torque, lb.-ft.	Rotation, deg.
150	9	450	10·5
300	10	—	—

TABLE III. *Head Load with Wind Load.*

Head Load, lb.	Deflection, in.
1,000	7·2
1,200	8·6
1,400	10·0
1,600	11·5

BREWERY REFRIGERATION PLANT

A RECONSTRUCTED CENTRALISED SYSTEM

Since the war, the proportion of beer distributed in bottles has steadily increased. This has meant that a considerable expansion of cold-room capacity has been necessary with a corresponding increase in the demands on the refrigerating plant. In the process adopted by Ind Coope and Allsopp, Limited, Burton-on-Trent, the beer is first matured in conditioning tanks, in which it is agitated by motor-driven propellers, and a secondary fermentation takes place. In this way a clean-drinking beer is produced and a pressure of carbon dioxide is developed. From the conditioning tanks the beer is transferred to a chilling plant which reduces the temperature to about 32 deg. F. The primary reason for chilling is to precipitate artificially the substances which would produce hazes at a later stage, when the beer is in bottle. The beer remains in the cold store for at least two weeks, during which time a natural clarifying action takes place. The haze-forming substances are then removed in two stages of filtration.

Formerly, there were five separate compressor houses each situated close to the department it served. Ammonia is the refrigerant used. On the Allsopp's side there were two 80-h.p., one 65-h.p. and one 55-h.p. compressors, together with all ancillary plant, while the Ind Coope side had two compressors of 65 h.p. and 30 h.p. with their ancillary plant. Two other compressors of 20 h.p. and 95 h.p. served the yeast rooms and attemporating plant, respectively. In addition, there were three Diesel engines, with an aggregate capacity of 120 h.p., which were used for operating chilling and air conditioning plant.

COMPRESSOR BUILDING

When it was decided that cold-room capacity should be increased, several schemes for augmenting the compressor plant were considered, but in the scheme finally adopted, the cold rooms, hop store, attemporating water plant and yeast rooms are all cooled from a single point. The site selected was formerly occupied by a number of maintenance shops, which fell into disuse when the maintenance department moved to other quarters. This site adjoins the new conditioning and cold rooms and is more or less central to all rooms where refrigeration is required, the farthest point being nearly a quarter of a mile away. The plant was designed by the engineering department of Ind Coope and Allsopp in co-operation with the company's technical director and the plant manufacturers, J. and E. Hall, Limited, Dartford, Kent. Work was started on the building in September, 1950, and as construction proceeded and bases were laid down the machinery was installed step by step. By September, 1952, this section of the reconstruction programme had been more or less completed.

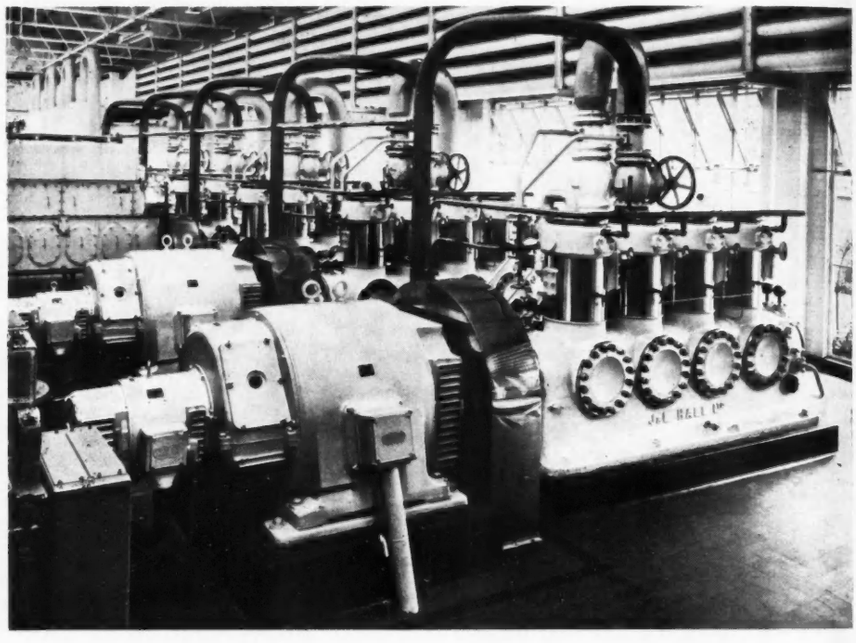
The building was designed by the architect's department of Ind Coope and Allsopp and the contractors were Ford and Weston, Limited, Osmaston-road, Derby. It consists of a single-storey structure 42 ft. wide and 300 ft. long with 11½-in. cavity walls, constructed of sand-faced bricks. The pitched asbestos roof is laid on "Tentest" boarding. Due to the poor load-bearing capacity of the subsoil it was necessary to excavate down to gravel and to provide mass-concrete foundations with an average thickness of about 10 ft.

POWER PLANT

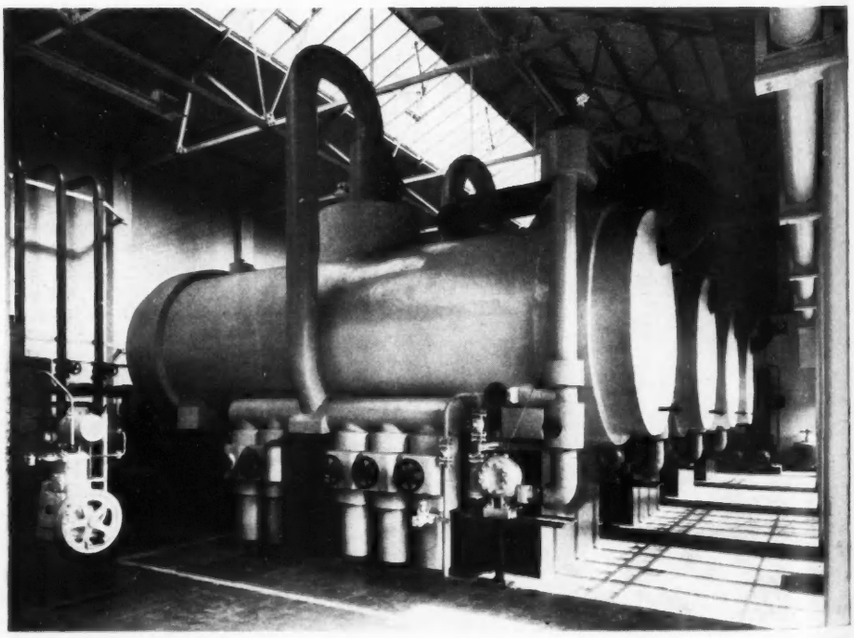
The compressor plant is housed in the main building and consists of five reciprocating compressors of the totally-enclosed vertical type, each having four cylinders of 10½-in. bore and 8½-in. stroke, designed to run up to 400 r.p.m. Each compressor is capable of extracting 3,000,000 B.Th.U.s per hour when running on the high-temperature duty, or 2,000,000 B.Th.U.s per hour when on the low. Four compressors can be in operation at the same time with the fifth acting as a standby. The total extraction can thus be 12,000,000 B.Th.U.s per hour or, expressed in tons refrigeration, 1,000 tons.

Cooling processes being continuous, it was considered essential to eliminate the possibility of breakdown by using two different sources of power. Therefore, three compressors are driven by Diesel engines and two by electric motors. The engines are Ruston and Hornsby five-cylinder 6 V.E.B. type which have a speed range suitable for the compressors and are capable of long periods of running and compressor driving. Each engine is fitted with a Streamline lubricating-oil filter.

Fuel oil for the Diesel engines is stored in three converted Lancashire boilers with an aggregate capacity of 18,000 gallons, equivalent to about six weeks' supply. From the boilers, the oil is fed by a motor-driven pump to three fuel service



Ammonia compressors: auto-synchronous motors in front, Diesel engines behind. The alternative power systems can ease peak loads and reduce noise at night.



Shell-and-tube ammonia evaporators showing inter-connection control valves. The petrol-driven air-compressor in the left foreground is the stand-by unit for charging the starting-air receivers.

tanks mounted above the engines, each tank having a capacity of 95 gallons and feeding the injector pumps by gravity. A hand pump is provided as a stand-by for the motor-driven pump.

Special provision was needed for starting the engines as they are directly coupled to the compressors without clutches. The compressors are fitted with hand-operated by-pass connections between the delivery and suction manifolds, but still require to be run up to speed. An adequate compressed-air supply was therefore provided by installing two air receivers with a capacity of 23·38 cub. ft. These receivers are charged by a Hamworthy air compressor, delivering 14 cub. ft. of air per minute at up to 300 lb. per square inch pressure, driven by a 5-h.p. motor. To provide a stand-by for the motor-driven compressor, a Ruston air compressor is provided, which is directly coupled to a 3-b.h.p. petrol engine and can deliver 10·6 cub. ft. of air per minute at up to 300 lb. per square inch. Cooling water for the Diesel engines is circulated through the engine jackets by electrically-driven centrifugal pumps and re-cooled by a natural-draught cooling tower. At present, borehole water is being used.

The remaining two compressors are driven by Crompton-Parkinson auto-synchronous type induction motors, developing 240 brake horsepower and operating at unity power factor.

The supply of refrigeration is thus ensured in the event of a failure of the electricity supply or of fuel oil. Moreover, by using the Diesel engines during the daytime and the electric motors at night, the level of noise is reduced to a minimum during the hours when it is most liable to give rise to complaints. Because of the proximity of houses it is important that all possible steps should be taken to keep down noise; each engine is therefore fitted with a Burgess exhaust silencer, in addition to the standard silencer. Another advantage of including Diesel-driven units in the compressor plant is that the peak electricity load is thereby eased.

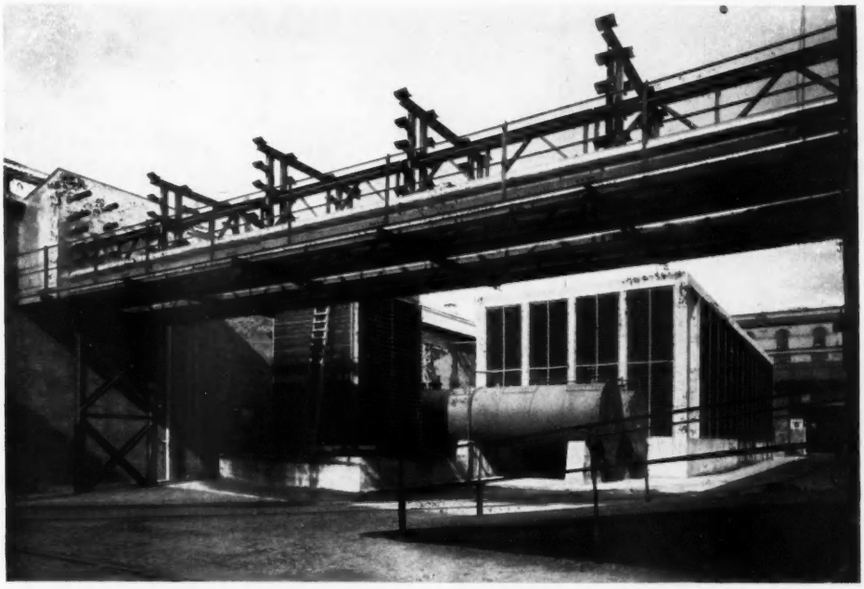
In the event of a failure of the electricity supply, power for the auxiliaries is provided by one of the two generating plants driven by oil engines, so that water, brine and oil can still be circulated.

COOLING SYSTEM

The ammonia is condensed in atmospheric evaporative condensers, which are arranged over a large concrete storage tank, extending for a total distance of about 250 ft. The coils are raised above the ground to ensure efficient cooling. There are five stacks of nine condensers each, which are connected by a system of 6-in. mains and valves so that any condenser can be used with any compressor. The evaporators are of the shell and tube type and can be retubed through the large windows. The design is such that the most efficient heat transfer is secured, and the plants operate on dry compression, which provides the maximum output for power absorbed by ensuring that no entrained liquid is carried back to the compressors.

Two very large brine-storage tanks are installed at the end of the engine room and occupy the full width of the building, there being low-temperature and high-temperature sections. These tanks contain calcium-chloride brine, which has the advantage that it provides a storage effect to cope with peak-load periods and can be pumped to the varying duties with a simple form of automatic control. The brine is circulated by 22 pumps with capacities ranging from 7½ to 10 h.p., and these are interconnected, so that should a pump which normally serves a particular building fail, its duty can immediately be taken over by another.

Brine circulating between the compressor house and the various cold rooms is piped to and from the building over three bridges. In order to conserve steel, use has been made of old Bailey bridges, which were modified and erected by the Burton Constructional Engineering Company, Limited, in conjunction with the architects department of Ind Coope and Allsopp.



Cooling tower for engine cooling water, fuel-oil storage tanks and ammonia condensers. The pipe-bridges are made from old Bailey bridges.

Located in a corner of the building is an Ellison's switchboard, which controls not only the central compressor house but also the whole of the chilling and conditioning rooms, the new cold rooms, all hot rooms, and the new laboratories. The mains supply is at 11 kV and the secondary supply at 415 bolts, three-phase current at 50 cycles being used. Apart from the auxiliary plant, the whole system of brine distribution is automatically controlled.

Throughout the central compressor house particular attention has been devoted to accessibility and ease of maintenance. Platforms have been provided to give easy access to the main valves of the compressors and provision is being made for a stairway across the top of the evaporators on to the brine tanks about 15 ft. above the compressor-house floor level. The front of the building has a series of detachable louvred ventilators over glass doors, to permit the easy removal of evaporator tubes and/or plant.

Wherever possible, pipes have been put in ducts below the floor level with ample room for access. In order to avoid dampness the pipe ducts are ventilated by air which is heated by passing it over the hot delivery pipe. The floor is of red quarry tiles and chequer plate has been laid over certain ducts. Throughout the building considerable trouble has been taken to ensure that no water is allowed to drip on to the floor. For instance, water from the glands of centrifugal pumps is piped away to the nearest drain.

GAINS BY CENTRALISATION

The scheme has increased the refrigeration capacity of the brewery approximately three times, and the new plant is capable of meeting additional demands such as the air conditioning of certain rooms, which form part of the future programme. If necessary, it can be expanded to meet other needs. Centralisation has eased the problem of maintenance considerably and has enabled a useful saving in staff, electrical energy and water to be achieved. Whereas each of the five former compressor houses had its own maintenance staff, the centralised plant can be supervised by two men per shift and the loading of compressors and condensers is more efficient. Situated in a corner of the building is an attendant's room and cabin from which the whole of the compressor house can be seen.

The machinery that has been replaced is earmarked for use in other breweries owned by the Group in Britain or overseas, and some of it has already been installed elsewhere.

All beer produced by Ind Coope and Allsopp at Burton is moved around the brewery by air and space has been made available at one end of the new compressor house for the pure-air plant, which is being transferred from other parts of the brewery.

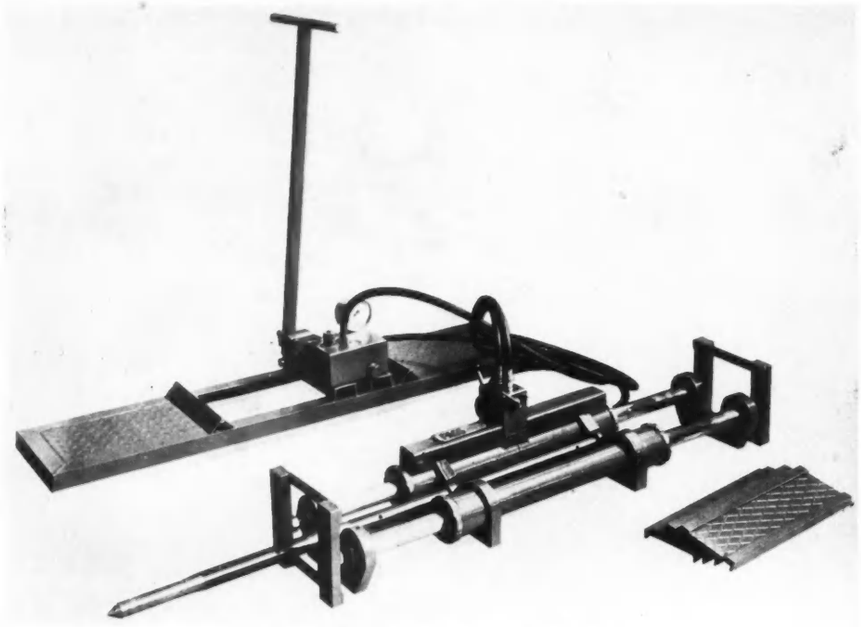
Also situated in a corner of the new building are two of the company's many borehole pumps. Water from a 1,400-ft. borehole is raised by a 62-h.p. Sulzer pump (supplied by Isler and Company, Limited) at the rate of 1,500 gallons per hour and is automatically controlled. The other unit is a Monopump which is raising water from another well.

The building has been designed to give maximum light and air. Ventilators are provided in the roof and a row of roof lights extends from north to south. Artificial lighting is by cold-cathode fluorescent fittings, the supply being split across three phases to avoid stroboscopic effects on moving machinery. The decoration is in accordance with Ind Coope and Allsopp's own colour scheme, which is based on the use of cream throughout with all service piping picked out in the company's standard colour code. In accordance with the technical director's usual policy the compressor house is surrounded by a garden planted with flowers, and shrubs, which provides a very pleasing border for this exceptionally long building.

★ ★ ★

TRANSATLANTIC TELEPHONE CABLE

Preliminary excavation work has been begun at the British terminal site of the first transatlantic submarine telephone cable, on the Gallanach estate, four miles south of Oban. The £12,500,000 scheme will link Britain with Canadian and United States telephone networks.



Pump and jacking unit of hydraulic thrust boring machine used for boring cable and pipe ways underground up to 120 ft. in length.

LAYING SERVICES UNDERGROUND

BORING MACHINE FOR MINIMUM EXCAVATION

A large part of the cost of laying services—for example, gas and water pipes or cables for electricity boards and the Post Office – consists of that of excavating the trench and of backfilling and consolidating the spoil. This is true whether the trench is dug by hand employing a relatively large labour force or, alternatively, if use is made of an expensive trenching machine. Elimination of trenching and making-good is made feasible, however, by the use of the hydraulic thrust boring machine shown in the accompanying illustration. This machine, made by E. Pass and Company, Limited, Holland-street, Denton, Manchester, comprises a pump and a jacking unit, together with ancillary equipment.

Exerting a thrust of up to 18 tons, the machine enables a clean straight bore to be achieved which is sufficiently oversize to permit the easy installation of many types of cable or conduit. In suitable ground, holes 120 ft. long have been successfully bored and this may be taken as the limiting capacity of the machine.

In practice, a small pit is dug at each end of the proposed bore-hole; for convenience, these pits are made to coincide with the manholes that will be ultimately required. The jacking unit is placed in the boring pit and suitably packed for alignment and level. In general, sighting rods and boning rods have proved adequate for successfully setting the jack in position. The pump is sited nearby.

The pilot rod with a guide collar and thrust collar is then put into the carriage of the jack and driven into the ground. This is followed by a 2⅞-in. diameter boring head and short boring bar which screws on to the pilot rod, and these are also driven into the ground as before. A 3-in. boring head and standard boring bar are then placed in the jack, coupled to the short boring bar, and together with as many additional boring bars as may be necessary, driven forward until the receiving pit is reached.

To facilitate driving it may be desirable to withdraw the pilot rod a few inches and then to thrust forward again, repeating this action several times before breaking through local hard spots. This is readily accomplished, for the movement of the carriage can be reversed instantly by use of the lever on the four-way valve mounted on the carriage of the jack.

When the boring is completed, the pilot and the 2⅞-in. head are removed and an enlarging head of the required size, together with an adaptor for withdrawing, are attached to the boring rod. Having attached the pipe or cable to be pulled back the machine is operated as before, except that a special screw for pulling the rods back is substituted for the thrust collar.

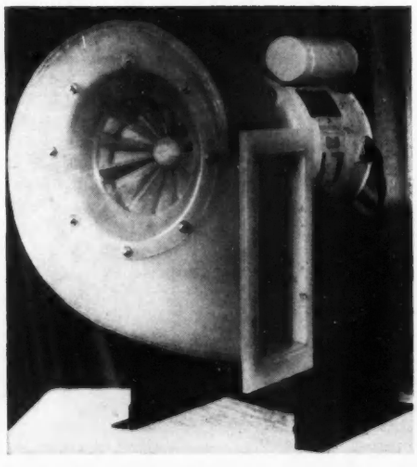
FANS AND DUCTING OF CORROSION-RESISTANT PLASTIC

Rigid plastic industrial sheet based on polyvinyl chloride has recently been adopted by Turner and Brown, Limited, Bolton, Lancashire, for the construction of a new range of exhaust fans and ducting, for use in chemical plant and laboratories. The material employed, Vybak VR215, supplied by Bakelite, Limited, 18, Grosvenor-gardens, London, S.W.1, has high impact and tensile strength, good dimensional stability, and exceptional resistance to chemical attack and weathering. The life of any Vybak exhaust installation, it is claimed, greatly exceeds that of protected metals.

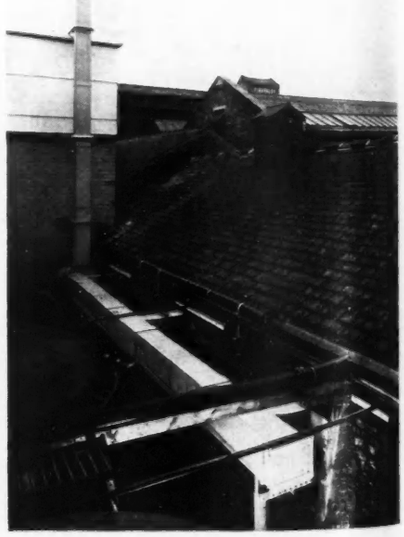
The fans have capacities ranging from 300 to 15,000 cub. ft. per minute, and are driven by fractional horse-power motors. The casing, impeller and impeller shaft are made entirely from Vybak rigid sheet, and no metallic parts are in contact with corrosive fumes. The casing is bolted to an outside frame of metal ; the arrangement allows the outlet to have 16 equi-arc positions as well as permitting the fan to be easily coupled to existing ducting, or fitted in small enclosed areas. The impeller has 12 blades round a central boss, and a hollow shaft to allow the introduction of the keyed steel shaft from the motor.

The fan illustrated is the Turbro Junior model, of 300 to 330 cub. ft. per minute capacity, for use in fume cupboards and small laboratories. It is driven by a ⅓-h.p. motor, from a single- or three-phase 50-cycle supply at 230/240 volts, at 1,450 r.p.m. The other illustration shows a Vybak ducting installation erected recently at the works of Thomas Burnley and Son, Limited, Gomersal, Yorkshire, by Turner and Brown, Limited, in place of a substantial protected-metal ducting for sulphur fumes which had collapsed through corrosion. Vybak sheet, ¼ in. thick, was selected both for its superior corrosion and weather-resistant properties and also since it could be installed with comparative ease. The ducting is composed largely of prefabricated sections, leaving little work to be done on the site.

Vybak polyvinyl-chloride sheet has been



The Turbro Junior exhaust fan for laboratories, chemical plant, etc. The casing, impeller, and impeller shaft are made from Vybak P.V.C. rigid sheet. This material is strong, has exceptional resistance to chemical attack, is easy to fabricate and can be " hot-gas " welded with matching rod.



This Vybak ducting for sulphur fumes has replaced protected-metal ducting which collapsed through corrosion.

specially developed to meet the need for a tough constructional material which can be machined and fabricated by methods similar to those used for sheet metals, though much more easily. It can be sawn, drilled, routed and milled, and can also be formed by heating above its softening point and cooling in contact with a former of the desired shape. It can also be "hot-gas" welded with matching rod. Since it is thermoplastic, it should not be used unsupported at temperatures above 60 deg. C., but up to this temperature it remains completely inert and tough. Tubing and rod extruded from similar compounds are also made for pipelines, valves, etc.

* * *

STOPPING AND STARTING A STOP-WATCH

Accurate Control by an External Circuit

An instrument designed to start and stop a stop-watch with great accuracy, by the discharge of condensers through an operating relay when contacts are closed in an external circuit, has been developed by Camerer Cuss and Company, 54-56, New Oxford-street, London, W.C.1, in conjunction with Allied Electronics Limited, 28, Upper Richmond-road, London, S.W.15. The manufacturers believe that it will be particularly suitable for time and motion study, electricmeter testing, reaction timing, and in fuel technology and armament research. The time interval meter, shown in the accompanying illustration, is portable and self-contained, being battery-operated, and is therefore free from errors arising from mains frequency variations. It is designed to measure time intervals down to 0·5 second.

Power for the meter is supplied by two internal standard deaf-aid Ever Ready Type B 105 batteries, which are automatically disconnected by an "economy" switch when the lid of the instrument case is closed. Times are recorded automatically by a standard stop-watch incorporated in the instrument, which is fitted with adaptor mounting rings so that it can take two sizes and a wide range of types of stop-watch. When the two external-circuit terminals are momentarily connected, the stop-watch will start and will continue to run until the terminals are again momentarily connected. The watch can be reset to zero by a built-in push button or can be controlled remotely.

Any type of remote control for starting and stopping the watch can be used, provided that the time between the release of the initiating pulse and the start of the terminating pulse is not less than 500 milliseconds, and that the resistance between the terminals is not greater than 12,000 ohms. For certain purposes, photo-electric cell units may be employed, and suitable units are available.

The time interval meter has been tested by the National Physical Laboratory; the following is an extract from their report on it: "Under given conditions, including any particular value of external resistance up to 12,000 ohms, the interval was found to be constant to well within ± 0·002 second. When the resistance in the external circuit was varied from 0 to 12,000 ohms the interval was found to change linearly by 0·012 second. Although this change is scarcely significant in relation to the errors inherent in any stop-watch, in service it can be eliminated by adjusting the start and stop circuits to be of equal resistance."

This instrument for stopping and starting a stop-watch is particularly suitable for time study, electric-meter testing, timing reactions, and armament research.

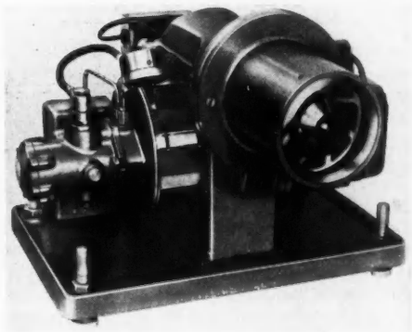
* * *

CANBERRA AIRCRAFT EQUIPPED AS AIR TANKER

An English Electric Canberra B Mk. 2 medium bomber aircraft, powered by two Rolls-Royce Avon engines, has been fitted as a tanker for refuelling in flight; it is the first British jet aeroplane to be so equipped. It has been lent to Flight Refuelling, Limited, Tarrant Rushton, Dorset, by the Ministry of Supply, to enable flight trials to be carried out on the latest developments in the probe-and-drogue flight-refuelling system at high altitudes and at high speeds. In previous trials in the United Kingdom only piston-engined aircraft have been used as tankers, although the receiver aircraft have been jet-powered fighters. The initial Canberra trials will be carried out in collaboration with a Gloster Meteor 8 acting as the receiver. In America, where the probe-and-drogue system designed by Flight Refuelling, Limited, has been tested by the United States Air Force and adopted for naval aircraft, a B-47B medium jet bomber aeroplane has been equipped as a tanker.

Conversion of the Canberra as a tanker has been carried out at Tarrant Rushton airfield, and has involved merely installing, in the bomb bay, the hose-drum unit which controls the flow of fuel from the tanker to the receiver and the "spring-blind" action of the hose. The installation has been carried out in a short time and at very low cost. Sir Alan Cobham, chairman and managing director of Flight Refuelling, Limited, has stated that, with this equipment, a bomber or transport aircraft with the necessary fixed fittings can be converted into a refuelling tanker in the minimum of time, since 70 per cent. of the equipment required is already installed for the purpose of ground refuelling. The remaining 30 per cent. can be added simply and quickly as a "package" unit.

Apart from the hose drum unit, which is connected up to the Canberra's normal existing fuel, hydraulic and electrical system, the only other equipment which it has been necessary to instal is a small operator's panel, from which the operation is controlled.



Automatic pressure-jet burner for gas, oil, or Diesel oil. The combustion head can be adjusted to provide optimum air velocity as well as the correct air flow for a particular load.

AUTOMATIC OIL BURNER

Combustion Head with Air Velocity and Volume Control

A new range of pressure-jet fully automatic oil burners, employing a combustion head designed to give an unusually high combustion efficiency, is being made by the Brockhouse Heater Company, Limited, West Bromwich, Staffordshire. At present, three light-oil models, of the type shown in the illustration above, are available for boilers rated between 75,000 and 600,000 B.Th.U. per hour. They are suitable for burning gas oil or Diesel oil having a viscosity not exceeding 70 seconds Redwood No. 1 at 100 deg. F.

The combustion head, which was evolved in the first place in the United States and has been developed further by a British oil company, is designed to give accurate control of the combustion air and to promote intimate mixing of the fuel and air so that an intense smokeless flame is produced, with a high CO_2 content in the flue gases. The head is easily adjustable to enable the correct volume of air for any given duty to be introduced at the optimum velocity – an important factor in obtaining a high combustion efficiency.

The fuel supply unit comprises a strainer, gear pump, pressure-regulating and shut-off valve. The body, cover and pump housing are cast in a high-grade alloy iron, and the pump gears are of alloy steel with accurately-generated tooth profiles. A solenoid valve in the hydraulic circuit connects the delivery port of the fuel pump to the suction port when the burner is "off." This valve is energised simultaneously with the burner motor so that, when the latter is switched on, the solenoid valve isolates the fuel-pump suction and delivery ports. The pump then delivers oil to the nozzle at the pre-set atomising pressure, surplus fuel being by-passed by the pressure-regulating valve. When the burner motor is de-energised by the boiler thermostat or pressure switch, the solenoid valve opens at the same time, giving a rapid shut-off at the burner nozzle and eliminating "dribble" and objectionable boiler pulsations while the motor and pump come to rest.

The standard burner is fitted with a ½-h.p. motor operating, at 1,425 r.p.m., from a 230/250-volt single-phase 50-cycle supply. The controls consist of a Satchwell control panel, a temperature controller and an immersion or surface boiler thermostat or pressure switch for steam-boiler applications. The burner unit can be supplied with a bedplate and adjustable feet, as shown in the illustration, or with a nozzle flange for mounting on the furnace front.

ELECTRIC POWER CONFERENCE

The 15th meeting of the International High Tension Conference (Conférence Internationale des Grands Réseaux Electriques à Haute Tension) will be held in Paris from Wednesday, May 12, to Saturday, May 22. The meeting place will be at the Fondation Berthelot, 28 Rue Saint Dominique.

In accordance with the wish of the Administrative Council the number of papers to be presented will be fewer than those at the last two conferences, in order to give more time for their previous study and to provide longer for discussion. The selection of papers has therefore been much more severe than heretofore and some National Committees have had to deal with three times the number of communications they are permitted to submit. This procedure is in accordance with suggestions that have been made in ENGINEERING and will, we hope, lead to a higher quality and greater interest in the proceedings.

The papers will be divided into four sections : generation, transmission and "cutting-off current" ; construction, insulation and maintenance of overhead and underground lines ; operation, protection and interconnection of networks; and power transmission over 220 kV. The last section is new and has been created owing to recent technical advances.

Those wishing to attend are requested to communicate as soon as possible with the secretary of the C.I.G.R.E., British National Committee, Thorncroft Manor, Dorking-road, Leatherhead, Surrey, especially as promptness may secure the advantage of a lower registration fee.

★ ★ ★

CABLE COMPOUND MANUFACTURE

The Dussek Bitumen and Taroleum Co., Ltd., Bow, London, who are celebrating their 50th anniversary, were among the first to arrange for shipments of crude Trinidad bitumen to this country. The bitumen was then refined in their works and used for protecting electric cables laid in wooden and other troughing, and for filling joint boxes. Later, as supply voltages rose, research was conducted on other insulating compounds, a high-voltage laboratory being established for this purpose. During the war, a cable-jointing compound was invented which required no heat and therefore eliminated the risk of accidental ignition.

★ ★ ★

REVISION OF BULK SUPPLY ELECTRICITY TARIFFS

The British Electricity Authority have given notice that a revised tariff for the supply of electricity in bulk to the Area Boards will come into force on April 1, 1954. This tariff will, as before, be in two parts, consisting of a fixed charge per kilowatt-hour of maximum demand and a running charge per kilowatt-hour consumed. The new fixed charge will be £4 15*s.* per kilowatt instead of £4 5*s.* 6*d.* per kilowatt, the maximum demand being measured on week days between the hours of 7 a.m. and 7 p.m. from Monday to Friday and between 7 a.m. and 12 noon on Saturdays. If this measured maximum demand is exceeded at other times there will be no additional charge, thus offering some encouragement to the development of off-peak loads.

The new running charge will be 0·5*d.* instead of 0·33*d.* per kilowatt-hour. The latter charge has been subject to a variation as the price of coal altered from a basic figure of 38*s.* per ton; a typical value for this adjustment being 0·0007*d.* per penny variation in the cost per ton. As the price of coal has risen since this figure was adopted the new tariff is based on a coal price of 60*s.* per ton and the adjustment figure has been reduced from 0·0007*d.* to 0·00065*d.* per penny variation in that price. This, although it may not be immediately obvious, means a small reduction in the running charge. For with a basic price of 38*s.* per ton and an actual price of 60*s.* per ton the fuel adjustment figure is 0·1848*d.*, or 264 times 0·0007*d.*; 264 being the difference in pence between 38*s.* and 60*s.* The total amount payable per kilowatt-hour has therefore been 0·33 + 0·1848*d.*, or 0·5148*d.* With a charge of 0·5*d.* per kilowatt-hour, a basic coal price of 60*s.* per ton, and a fuel adjustment figure of 0·00065*d.* per penny variation in that price, the total amount payable will be 0·50065*d.* per kilowatt-hour, a difference which although small represents a large sum when the number of kilowatt-hours involved is considered. This adjustment is intended to reflect the continuing improvement in thermal efficiency.

ENGINEERING INDUSTRY AND THE BUDGET

PROPOSED REDUCTIONS IN PURCHASE TAX AND OIL DUTY

The Engineering Industries Association, 9, Seymour-street, Portman-square, London, W.1, have called the attention of the Chancellor of the Exchequer to a number of features in existing financial legislation which, in their opinion, should receive prior consideration as and when relief becomes possible. They have done so because they maintain that the surest way to economic stability lies through the encouragement of genuine effort and enterprise, as well as through the ability of industry to improve its efficiency out of retained earnings.

Representations have already been made regarding the taxation of profits, incomes and retirement benefits, as well as on estate duty, to the bodies which are inquiring into these subjects ; and it is hoped that some of the principles and amendments advocated may be implemented in the coming Finance Bill.

PURCHASE TAX AND PRODUCTION

The Association view with extreme concern the disastrous effects which the purchase tax is having upon production in so many industries. These effects are not felt only in the manufacture of components and tooling equipment and in the ancillary operations which are preliminary to final production ; they also extend to markets in products which may not be subject to purchase tax at all because the public is largely unaware of the operative rates of the tax upon wide ranges of articles and probably exaggerates the range of goods covered. The seriousness of the situation is illustrated by calling attention to the fact that sale or return operations have had to be devised in certain industries with a view to persuading retailers to relieve manufacturers of stocks during the four months prior to the budget, so that production shall not be brought to a standstill. This policy does not, however, prevent the public from curtailing their purchases from January to April, a practice that is likely to become more marked now that annual reductions in purchase tax rates may be anticipated.

It is therefore contended that purchase tax should be reduced to a minimum in view of its inherently bad features and because the regulations regarding it are still riddled with anomalies. It creates a distortion in values and causes inflation, because it increases the prices of so many articles which are on the borderline of accessibility to the average spending public.

In adopting the dual policy of reduction and simplification it is maintained that some system of priorities should be observed, and that particular regard in this connection should be paid to items which enter into the overhead expenses of manufacturers and thus augment the cost of production of the manufactured product. Goods which have a high export potential should receive special consideration where it is necessary that both home and overseas markets should be encouraged, in order that costs may be kept down to a competitive level in comparison with foreign products of the same nature. Items which are of a utility nature and thus enter into the normal cost-of-living of the population as a whole, and items where manufacture should be encouraged to avoid the complete loss of a craft to the nation, should receive specially favourable treatment. Finally, a definite and immediate policy should be adopted whereby appropriate reductions can be achieved, within as short a period as possible, so that the disruption of trade and production may be minimised and the tax be stabilised at the lowest level.*

DUTY ON HYDROCARBON OILS

Turning to other questions, the Association maintain that in view of the high proportion of petrol and Diesel oil consumption which appears in production costs as transport charges, the duties on these commodities should be reduced, especially as they also directly affect the cost of living. These high duties have, moreover, nullified the encouragement given by the reduction in licence rates to the manufacture of high-powered private cars. These cars are the most suitable for the export market, and the present trend of the British motor industry towards cheap models of very low horse-power must be detrimental to expansion in this direction.

Attention is also drawn to the damaging effect of the present profits tax system upon the availability of risk capital. The Association therefore calls for the abolition of this tax on undistributed profits and for a reduction in the tax on distribution from 20 to 10 per cent. It is again proposed that the industrial buildings allowance should be extended to all commercial buildings, in accordance with the recommendations of the Millard Tucker Committee.

INCOME TAX RELIEF

If further relief in income tax becomes possible it is advocated that the most equitable method of granting this would be by a reduction in the standard rate, with a comparable decrease in the reduced rates. This would mean that every taxpayer would benefit and that the taxable profits of industry would be relieved. It is not, however, considered that there is any necessity for the removal of a further stratum of citizens from their responsibilities as income-tax payers.

* A number of reductions in purchase tax, mainly on goods of a non-engineering character, were announced by the Treasury on Monday, January 4 – Ed., E.

Labour Notes

ELECTRICIANS' STRIKE PROPOSALS

Provisional arrangements for a week of "guerrilla" strikes, to commence next Monday, were announced by the executive committee of the Electrical Trades Union on January 2. Important building sites at atomic-energy establishments, guided-missile research stations, oil refineries, air ports, gasworks and motor-car manufacturing factories are reported to have been selected for these demonstrations. A week later, on January 18, the date previously selected by the Confederation of Shipbuilding and Engineering Unions for the commencement of the bans on overtime and piece-rate working in shipyards and engineering establishments, a 24-hour nation-wide strike is due to be put into operation.

These actions are to be taken by the union as a protest against the failure of the employers' organisation, the National Federated Electrical Association, to concede a substantial increase in wage rates. For about a year, the union has been endeavouring to obtain a wage increase for men employed in the electrical-contracting industry, estimated to number nearly 50,000, and it is understood that the advances desired are 3*d.* an hour more for men in the London area and 2½*d.* an hour more for men working elsewhere.

It may be recalled that similar tactics were resorted to by the union in August and September last, when the ensuing strikes at important building sites led to the setting up of a court of inquiry by Sir Walter Monckton, the Minister of Labour. This body, in its report on October 14, recommended that the union and the National Federated Electrical Association should re-open their negotiations on the wage claim and that, in the event of the two sides still being unable to agree, the dispute should be referred to arbitration.

RELUCTANCE TO SEEK ARBITRATION

In accordance with this recommendation, a number of joint meetings between representatives of the two organisations have taken place, but, unfortunately, these appear to have served only to emphasise the reluctance of the employers' Association to agree to the "substantial" increase demanded and the unwillingness of the union to refer their case to arbitration.

Reasons for the union's attitude towards arbitration were outlined in the December issue of its official *Journal*. Briefly, these included a feeling that the Association might not accept a decision in the men's favour and the view that arbitration was largely a "gamble," because members of arbitration tribunals were sometimes influenced by other considerations than the living standards of employees, and took into consideration the level of exports and profit percentages.

On their side, the employers have been reluctant to take the initiative in referring the dispute to arbitration because they have maintained that, in the present condition of the industry, no wage increase was justified, and considered that any appeal to arbitration by them might be taken as a tacit admission to the contrary. They also appear to have felt that, in view of the scepticism of arbitration shown by the union's officials, resort to it by the Association might do harm rather than good.

Both sides have been in frequent touch with the Ministry of Labour, and the Ministry's conciliation officers met officials of the Association and the union separately last Monday but were unable, apparently, to alter the union's intentions. Recent offers by the Association to refer the claim to arbitration, if the union would agree to that course, were repeated on Monday, and rejected by the union. Mr. F. Foulkes, the union's President, said that, although the men's leaders would meet anyone at any time in order to obtain a settlement, they would not accept arbitration and, in their view, there was no point in another court of inquiry being held. An emergency meeting of the Association's council took place on Tuesday.

UNIONS POSTPONE ENGINEERING OVERTIME BAN

Proposals to ban overtime and strictly limit piece-rate working in the engineering and shipbuilding industries, due to be put into operation on January 18, were postponed by the executive council of the Confederation of Shipbuilding and Engineering Unions last Monday. This decision, which was carried, in the face of strong opposition, by 16 votes to 9 on a show of hands, was taken in response to a request by the Minister of Labour that no protest action on the Confederation's wage claims should be introduced while the courts of inquiry investigating the claims were sitting.

These courts, one to examine the wage situation in the engineering industry, and the other to examine that in the shipbuilding and ship-repairing industry, were set up by the Minister of Labour on December 31 and will commence their hearings, in public, to-day. Lord Justice Morris, a Lord Justice of Appeal, has been appointed to be the chairman of both courts and the membership of each court is the same, comprising Sir Harold G. Howitt, G.B.E., F.C.A., and Mr. H. Lloyd Williams, barrister and member of the Industrial Court, as independent members; Sir Robert Sinclair, K.C.B., K.B.E., past-President of the Federation of British Industries, representing the employers' organisations; and Mr. C. J. Geddes, C.B.E., general secretary of the Union of Post Office Workers, as a trade-union representative.

The decision to recommend a ban on overtime and the limitation of piecework was taken at a conference of executive officials of the 39 unions affiliated to the Confederation, held in London on December 23. This action was agreed to as a means of protesting against the rejection by the Engineering and Allied Employers' National Federation and the Shipbuilding Employers' Federation of the unions' demands for an all-round wage increase of 3*s.* in the pound for adult male employees.

It was left to the Confederation's executive council to vary the decision of the special delegate conference if thought desirable.

HIGHER WAGE RATES

Changes in the rates of wages which came into operation in the United Kingdom during November last resulted in an aggregate increase of about £109,000 in the weekly full-time wages of some 457,000 employees. Those principally affected by the higher wage rates included persons employed in refreshment establishments and in the retail newsagency, tobacco and confectionery trades in England and Wales.

Among others receiving increases were workpeople engaged in electrical-cable making, shift workers in electricity-supply undertakings, and persons employed in paint, varnish and lacquer manufacture. On the other hand, some 98,000 operatives, mainly in the boot and shoe industry, had their wages reduced by small amounts, in accordance with sliding-scale agreements based on the index of retail prices. These decreases amounted to a total of £21,000 a week.

According to statistics published in the December issue of the *Ministry of Labour Gazette*, a total of some 8,209,000 workpeople received increases in their weekly wage rates amounting to £2,243,000 net during the eleven months from January to November last year. The largest increase was in the building and contracting industry, in which 1,115,000 persons had their wages raised to the extent of over £390,000 a week.

In the first eleven months of 1952 there was a net increase of £4,321,000 in the weekly full-time wages of 11,180,000 workpeople.

FEWER DAYS LOST IN INDUSTRIAL DISPUTES

Up till the end of November, last year had been less affected by industrial stoppages than any year since 1941, but the one-day token strike in the engineering and shipbuilding industries on December 2 will, of course, substantially increase the total of persons involved for the twelve months ended December 31, 1953.

During the first eleven months of last year, 1,624 strikes commenced, and in all the disputes in progress during the period some 274,900 workpeople were involved and approximately 1,053,000 working days were lost. The comparative figures for the corresponding eleven months of 1952 were 1,626 strikes commenced, with 361,800 persons taking part in all strikes in progress and 1,657,000 days lost. During the whole of 1941, some 1,250 strikes began and, in all, 361,000 employees were affected and lost a total of 1,079,000 working days. In the above figures, the numbers of employees involved and days lost include those arising from disputes which were already in being when the respective periods began.

From the foregoing figures, it will be noted that, although the strikes occurring during the corresponding periods of 1952 and 1953 were very alike in numbers, 1,626 compared with 1,624, the tendency during last year was for disputes to involve fewer persons and to be settled more quickly. In both years, the three industries most seriously affected were the coal-mining, vehicle-building, and building and contracting. During the first eleven months of 1953, there were no fewer than 1,217 stoppages in the mining industry. In these, 156,800 persons took part and lost 369,000 days' work. In the vehicle-building industry, there were 45 strikes, with 29,800 persons involved and 287,000 working days lost; and, in the building and contracting industry, there were 77 strikes, with 11,900 persons involved and 92,000 days lost.

In the engineering industry, from January to November, 1953, there were 42 disputes, which involved a total of 9,700 workpeople and caused the loss of 58,000 days, while, in the shipbuilding and ship-repairing industry, there were 49 stoppages, which involved 7,800 persons and caused the loss of 66,000 days.

During November last year, 202 stoppages were in progress, in which 39,300 persons took part and 93,000 days were lost. In the previous month, October, 1953, there were 232 stoppages, with 40,700 employees taking part and 117,000 days lost.

★ ★ ★

EXHIBITION OF POWER-FACTOR CORRECTION EQUIPMENT

The Midlands Electricity Board are to hold an exhibition featuring power-factor correction at their industrial showrooms, 247, Chester-street, Birmingham, 6. It will be open from January 11 to 22, inclusive, and will contain examples of power-factor correction equipment, as made by several manufacturers, together with graphs showing the effect on electricity costs. Working demonstrations will also be given.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Switchgear," by K. N. Swash. Central London Branch. St. Ermin's Hotel, S.W.1. Mon., Jan. 11, 7 p.m.

BRADFORD
"Navigation," by J. Whiteley. Midland Hotel, Bradford. Wed., Jan. 13, 7.30 p.m.

KENTON
"Industrial Lighting." Discussion. North-West London Branch. Rest Hotel, Kenton-lane, Kenton. Tues., Jan. 12, 8.15 p.m.

YORK
"Estimating," by T. Howell. City Hotel, Lendal, York. Wed., Jan. 13, 7.30 p.m.

British Institution of Radio Engineers

NEWCASTLE-UPON-TYNE
Short papers by students. North-Eastern Section. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Wed., Jan. 13, 6 p.m.

Chemical Engineering Group

LONDON
"Engineering and Microbiological Processes," by F. E. Warner, A. M. Cook and D. Train. Geological Society, Burlington House, Piccadilly, W.1. Tues., Jan. 12, 5.30 p.m.

Chemical Society

SWANSEA
"Some Recent Developments in Theoretical Organic Chemistry," by Professor M. J. S. Dewar. University College, Swansea. Fri., Jan. 15, 5.30 p.m.

Cleveland Institution of Engineers

MIDDLESBROUGH
"Flame Radiation and Productivity," by M. W. Thring. Cleveland Scientific and Technical Institution, Corporation-road, Middlesbrough. Mon., Jan. 11, 6.30 p.m.

Incorporated Plant Engineers

BIRMINGHAM
Contractors' Plant Discussion Group. Imperial Hotel, Birmingham. Fri., Jan. 15, 7.30 p.m.

DUNDEE
"Maintenance of Electric Motors," by A. D. Christie. Mather's Hotel, Dundee. Mon., Jan. 11, 7.30 p.m.

MANCHESTER
"Fan Engineering," by C. Gordon Huntley. Engineers' Club, Manchester. Tues., Jan. 12, 7.15 p.m.

NEWCASTLE-UPON-TYNE
"Tobacco Processing," by E. W. Watson. North-East Branch. Roadway House, Oxford-street, Newcastle-upon-Tyne. Thurs., Jan. 14, 7 p.m.

NOTTINGHAM
"Gas and Oil Engines," by A. C. Yates. East Midlands Branch. East Midlands Gas Board's Offices, Parliament-street, Nottingham. Wed., Jan. 13, 7 p.m.

Institute of British Foundrymen

MANCHESTER
"The Running and Feeding of Castings," by R. W. Ruddle. Engineers' Club, Manchester. Wed., Jan. 13, 7 p.m.

Institute of Fuel

LONDON
"New Carbonisation Processes under Development and Their Relation to Established Practice," by D. T. Barritt and T. Kennaway. Joint meeting with the Coke Oven Managers' Association (Southern Section). Waldorf Hotel, Aldwych, W.C.2. Tues., Jan. 12, 5.30 p.m.

NEWCASTLE-UPON-TYNE
"The Calorific Value of Coal," by J. Brown. North-Eastern Section. King's College, Newcastle-upon-Tyne. Mon., Jan. 11, 6.30 p.m.

Institute of Metals

SWANSEA
"Continuous Casting," by J. Crowther. South Wales Local Section. University College, Singleton Park, Swansea. Tues., Jan. 12, 6.45 p.m.

Institute of Petroleum

LONDON
"The Stability and Compatibility of Fuel Oil and Diesel Fuel," by C. W. G. Martin and D. R. Bailey. Wed., Jan. 13, 5.30 p.m.

Institute of Welding

CHATHAM
"Jigs and Fixtures for Welding." Discussion. Medway Section. Sun Hotel, Chatham. Thurs., Jan. 14, 7.15 p.m.

Institution of British Agricultural Engineers

LONDON
"The Control of Weeds by Tillage," by F. Coleman. Institution of Electrical Engineers, Savoy-place, Victoria-embankment, W.C.2. Tues., Jan. 12, 2.15 p.m.

Institution of Civil Engineers

LONDON
"The Control of Aircraft Movement at Airports," by Clifford Heyes and E. J. Dickie. Airport Engineering Division. Tues., Jan. 12, 5.30 p.m.

BIRMINGHAM
"Problems of Water Supply in Arid Regions," by Dr. F. W. Shotton. Midlands Association. James Watt Memorial Institute, Birmingham. Thurs., Jan. 14, 6 p.m.

Institution of Electrical Engineers

LONDON
Film Evening. London Students' Section. Mon., Jan. 11, 7 p.m.
"A Single-Sideband Controlled-Carrier System for Aircraft Communication," by G. W. Barnes. Radio Section. Wed., Jan. 13, 5.30 p.m

FARNBOROUGH
"Electronic Speed Control of Motors," by J. C. Rankin. Southern Centre. Royal Aeronautical Establishment Technical College, Farnborough. Wed., Jan. 13, 7.30 p.m.

HULL
"Inherent Current, Voltage and Speed Control in Dynamo-Electric Machinery," by J. C. Macfarlane, Dr. J. W. Macfarlane and W. I. Macfarlane. North Midland Centre. Yorkshire Electricity Board's Offices, Ferensway, Hull. Thurs., Jan. 14, 7.15 p.m.

MALVERN
"Transmission of Pictures by Radio," by A. W. Cole. South Midland Centre. Winter Gardens Restaurant, Malvern. Thurs., Jan. 14, 7.15 p.m.

NEWCASTLE-UPON-TYNE
"The Technique and Development of Automatic Winding in Mine Shafts," by B. L. Metcalf and G. Cuttle. North-Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Jan. 11, 6.15 p.m.

Institution of Engineers-in-Charge

LONDON
"Modern Petroleum Refining," by F. J. Patman. Wed., Jan. 13, 6.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

DUNDEE
"The Manufacture of Small Refrigeration Units," by S. H. Pearson. Joint Meeting with the Dundee Institute of Engineers. University College, Dundee. Thurs., Jan. 14, 7.15 p.m.

GLASGOW
"The Manufacture of Small Refrigeration Units," by S. H. Pearson. Tues., Jan. 12, 6.45 p.m.

Institution of Mechanical Engineers

LONDON
"The Changing Processes of Internal-Combustion Engines with Special Reference to the Two-Stroke Cycle," by Dr. Hans List. Automobile Division. Tues., Jan. 12, 5.30 p.m.

EDINBURGH
"Application of Atomic Energy to Power Production," by Dr. S. C. Curran. Scottish Branch. North British Station Hotel, Edinburgh. Fri., Jan. 15, 6.30 p.m.

DERBY
"Continental Cars," by Laurence Pomeroy. Automobile Division. Midland Hotel, Derby. Mon., Jan. 11, 7.15 p.m.

Institution of Naval Architects and Institute of Marine Engineers

PORTSMOUTH
"Ships' Stabilisers," by Sir William Wallace. Southern Joint Branch. Municipal College, Portsmouth. Wed., Jan. 13, 7.30 p.m.

Institution of Production Engineers

LONDON
"Fabrication and Welding of Armoured Steels," by J. W. Brind. Royal Empire Society, Craven-street, W.C.2. Thurs., Jan. 14, 7 p.m.

BLACKBURN
"Design of Sintered Metal Parts," by G. R. Bell. Crown Hotel, Blackburn. Preston Branch. Wed., Jan. 13, 7.15 p.m.

LEICESTER
"The Application of Milling Cutters," by A. Loudon. Bell Hotel, Leicester. Thurs., Jan. 14, 7 p.m.

SHEFFIELD
"Extrusion of Metals," by J. T. Lewis. Grand Hotel, Sheffield. Mon., Jan. 11, 6.30 p.m.

Institution of the Rubber Industry

LONDON
"Calendering," by E. O. Shead. Royal Society of Tropical Medicine and Hygiene, 26 Portland-place, W.1. Tues., Jan. 12, 5.30 p.m.

BIRMINGHAM
"What the Aircraft Manufacturer Wants from the Rubber Industry," by J. H. Cork. Midland Section. James Watt Memorial Institute, Birmingham. Mon., Jan. 11, 6.45 p.m.

LEICESTER
"Extruders and Extrusion," by H. C. Harrison. Bell Hotel, Leicester. Wed., Jan. 13, 7.30 p.m.

PRESTON
"The Role of Latex in the Rubber Industry," by E. W. Madge. Bull and Royal Hotel, Preston. Mon., Jan. 11, 7.15 p.m.

Institution of Structural Engineers

LONDON
"The Design of Chimneys," by E. G. Robinson. Graduates' and Students' Section. Tues., Jan. 12, 6 p.m.

LIVERPOOL
"The Plastic Theory and Its Application to Welded Structures." Discussion. Lancashire and Cheshire Branch. College of Technology, Liverpool. Tues., Jan. 12, 7.15 p.m.

MIDDLESBROUGH
"Lackenby Works," by A. P. Clark. Northern Counties Branch. Cleveland Scientific and Technical Institute, Middlesbrough. Tues., Jan. 13, 6.15 p.m.

Junior Institution of Engineers

LONDON
"Coal Tar Fuels," by E. Brett Davies. Townsend House, Greycoat-place, S.W.1. Fri., Jan. 15, 7 p.m.

MANCHESTER
"Junior Associations and the Training of Supervisory Staff and Foremen." Chairman's Address by A. R. Bateman. North-Western Section. Engineers' Club, Manchester. Mon., Jan. 11, 7.30 p.m.

SHEFFIELD
"Clean City Air: An Engineer's Problem," by James Law. Livesey Clegg House, Union-street, Sheffield. Mon., Jan. 11, 7.30 p.m.

Liverpool Metallurgical Society

LIVERPOOL
"The Corrosion and Preservation of Metals." Open Discussion. Thurs., Jan. 14, 7 p.m.

Newcomen Society

LONDON
"Some Notes on the Origins of Mechanical Servo Mechanisms," by H. G. Conway. Iron and Steel Institute, 4 Grosvenor-gardens, S.W.1. Wed., Jan. 13, 5.30 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
"Metallurgical Aspects of High-Temperature Steam and Gas Turbine Plants," by Dr. J. M. Robertson. Mining Institute, Newcastle-upon-Tyne. Fri., Jan. 15, 6.15 p.m.

Royal Society of Arts

LONDON
"Stereo-Cinematography," by Dr. Leslie Knopp. Wed., Jan. 13, 2.30 p.m.
"The Colombo Plan," by A. C. B. Symon. Thurs., Jan. 14, 5.15 p.m.

Royal Statistical Society

LONDON
"Personnel Management and Statistics," by Colonel Bernard Ungerson. Study Section. Lighting Service Bureau, 2 Savoy-hill, W.C.2. Wed., Jan. 13, 6 p.m.

GLASGOW
"That Statistical Quality Control is not Applicable to Heavy Industry." Debate. Glasgow Industrial Applications Section. 39 Elmbank-crescent, Glasgow, C.2. Mon., Jan. 11, 7.30 p.m.

NEWCASTLE-UPON-TYNE
"Machine Utilisation," by M. J. Moroney. North-Eastern Industrial Applications Section. Crown Hotel, Clayton-street, Newcastle-upon-Tyne. Tues., Jan. 12, 7 p.m.

Society of Instrument Technology

LONDON
"Theory and Design of Compound-Action Automatic Controllers, with Reference to the Interaction Factor," by H. Williamson. Annual Meeting of Control Section. Manson House, Portland-place, W.1. Thurs., Jan. 14, 6 p.m.

The address of the headquarters of each Institution is given in the following list. Meetings held in the headquarters town are held at this address unless otherwise stated. Particulars for insertion in this column should reach the Editor not later than Monday morning in the week preceeding the date of the meeting.

Association of Supervising Electrical Engineers, 54 Station-road, New Barnet, Hertfordshire.
British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1.
Chemical Engineering Group, 56 Victoria-street, London, S.W.1.
Chemical Society, Burlington House, Piccadilly, London, W.1.
Cleveland Institution of Engineers, 5 Ambleside-road, Normanby, Middlesbrough.
Incorporated Plant Engineers, 48 Drury-lane, Solihull, Birmingham.
Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3.
Institute of Fuel, 18 Devonshire-street, Portland-place, London, W.1.
Institute of Marine Engineers, 85 The Minories, London, E.C.3.
Institute of Metals, 4 Grosvenor-gardens, London, S.W.1.
Institute of Petroleum, Manson House, 26 Portland-place, London, W.1.
Institute of Welding, 2 Buckingham Palace-gardens, London, S.W.1.
Institution of British Agricultural Engineers, 24 Portland-place, London, W.1.
Institution of Civil Engineers, Great George-street, London, S.W.1.
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2.
Institution of Engineers-in-Charge, St. Bride Institute, Bride-lane, London, E.C.4.
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2.
Institution of Mechanical Engineers, 1 Birdcage-walk, London, S.W.1.
Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1.
Institution of Production Engineers, 36 Portman-square, London, W.1.
Institution of the Rubber Industry, 12 Whitehall, London, S.W.1.
Institution of Structural Engineers, 11 Upper Belgrave-street, London, S.W.1.
Junior Institution of Engineers, 39 Victoria-street, London, S.W.1.
Liverpool Metallurgical Society, 9 The Temple, 24 Dale-street, Liverpool, 2.
Newcomen Society, Science Museum, South Kensington, London, S.W.7.
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne, 1.
Royal Society of Arts, John Adam-street, Adelphi, London, W.C.2.
Royal Statistical Society, 4 Portugal-street, London, W.C.2.
Society of Instrument Technology, 55 Tudor-gardens, London, W.3.